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The Index for the 1921 Volume

For the past two years the *Railway Mechanical Engineer* has printed only a limited edition of the annual index, which has been mailed to subscribers upon request. As this practice has apparently been entirely satisfactory it will be continued this year. Copies of the index for 1921 will be ready soon after the December issue is off the press and those desiring copies should notify the Circulation Department not later than January 1, 1922.

The June Convention Program

The announcement by the Mechanical Division of the American Railway Association of the decision to hold a convention at Atlantic City in June will meet with general approval among the members, many of whom were disappointed that no meeting was held this year. It is inevitable that interest should decline if no meetings are held and unless the Mechanical Division adopts a constructive and aggressive policy there is danger that it will not retain the proud position held by the Master Mechanics' and Master Car Builders' Associations for so many years.

The possibilities for constructive work were never greater than they are today. As pointed out by Mr. Tollerton in his address as chairman of the 1920 convention, the Transportation Act is causing a greater and more insistent demand for railroad operation under conditions of maximum efficiency. This should be the guiding thought in outlining the work of the association. In the past, and especially in recent years, the mechanical association has not measured up to the broad responsibility that Chairman Tollerton has outlined. The problems of the mechanical department embrace far more than merely the technical problems of the design and operation of equipment. The program of the association has become narrower when it should have widened its scope.

Foremost among the topics that should receive attention is the ever-important matter of an enlightened labor policy. A. H. Smith, president of the New York Central, recently said "The efficiency of a railroad depends principally upon its men. It is estimated that 95 per cent of railroading is human." If the matter is considered merely from the standpoint of the expenditure involved, the importance of the labor question is evident. In 1920 of every dollar spent for maintenance of equipment, 68 cents was paid for labor and 32 cents for materials. Mechanical officers find it advantageous to discuss at the conventions their common problems of getting the best service from material or getting the most power from coal. Would it not also pay them to consider the problems of recruiting, training and supervising labor in order to get the best possible return for the payroll expenditure, which for the year 1920 amounted to over $1,000,000,000 for the mechanical department alone? Surely there is a field for personnel work which the association cannot afford to ignore.

Another big field as yet almost untouched is to be found in the mechanical problems of operation. The question of economical speed and tonnage is of primary interest to the operating officer, but to determine the best practice requires a knowledge of the characteristics of the locomotive which the mechanical department officer alone possesses. It is to be hoped that eventually the mechanical association will number among its committees one on the economics of operation.

Some attention has been given to shop design and management in recent years but much more could be done along these lines. In the equipment field, to which the association has devoted most of its attention in the past, there are notable developments under way. The possibilities before the Mechanical Division are practically unlimited, and if its work

is extended to include the big problems which the mechanical department must face, there should be opened to the organization a new era of constructive activity.

Gasoline Motor Cars for Branch Line Service

Considerable interest was aroused a number of years ago in the development of a gasoline-engine-driven rail motor car for use on branch and short lines where the passenger traffic was so light that only one or two trains a day were operated. In many sections there was also an added interest due to the construction of competitive interurban electric roads which, with their frequent regular service, were able to secure a profitable traffic, whereas the railroad with its limited number of trains was failing to earn even operating expenses. To meet this demand a number of different designs were brought out by several companies—some of these cars having mechanical transmission and some electric transmission. Several were excellent examples of the railroad car builders' art and provided every facility to which the traveling public had become accustomed. They were commonly heavy, often larger than was really necessary and required engines of very large size that have since been found to be beyond the practical limits of power for gasoline engines. As these cars could not be profitably operated, railroads lost interest in them.

Since that time there has been a tremendous development in motor truck design and the railroad branch line now is facing the competition of the motor bus running on parallel highways. Many of these railroad lines with their small density of traffic are valuable as feeders and the traffic available would be a profitable source of revenue if it could be handled at a lower cost than is possible by steam locomotive operation. In this connection the fact should not be overlooked that the railroad with its moderate grades, easy curves and steel rails when equipped with motor cars would be able to furnish smoother riding, carry heavier loads and operate such cars at lower maintenance and power costs than is possible for motor cars operated on highways.

What the railroads should do is to make full use of the accumulated engineering experience of the motor truck builders, use engines of a size and design which have already demonstrated their efficiency, employ transmission and other details which have been developed, design a body as light as possible and mount it on well-designed trucks. By so doing the renewed activity in railway motor car construction should soon result in a number of designs which could be operated to advantage and with economy.

Manufacture of Standard Small Tools

Railroad shop tool rooms have frequently been called upon to make milling cutters, reamers and various small tools. The practice often has been started on account of the difficulty in having requisitions passed or the delay in securing devices not regularly carried in quantity in storeroom stock, but which may have been needed promptly to avoid delays in doing necessary work. It having been shown that the tool room was capable of doing the work, there is a tendency oftentimes to continue the practice. It is doubtful, however, whether any railroad tool room has the equipment or can manufacture such small tools in sufficient quantity to do so at a price as low as they can be bought in the open market. In comparing costs it must be remembered that direct labor and material represent only a part and frequently the smaller part of the actual cost. Superintendence, interest and depreciation of machine tools and buildings, power, light, heat and other elements are just as much factors of cost as are the direct labor and material.

Unfortunately railroads do not calculate their costs as accurately as is desirable. Even manufacturing plants with highly equipped tool rooms and which use many times the number of cutters and small tools required by railroad shops have found by careful cost investigation that such devices can be purchased from specialists cheaper than they can be manufactured. The trend of profitable commercial manufacturing is more and more toward limiting the product to a small line which can be produced in a quantity which will warrant the outlay for the most complete equipment of machinery and devices for the particular product and then purchase small tools and other devices, except special jigs and fixtures that are not a regular product of any other manufacturer. Even such devices can and frequently are obtained from some one who makes a specialty of such work. The railroad shop, often with advantage, can learn a lesson from the outside manufacturing shop which watches its costs with extreme care. Except in emergencies and in cases where small tools cannot be procured from outside manufacturers, investigation will show the economy of purchasing instead of making such articles.

Bronze-Faced Semi-Steel Castings

Elsewhere in this issue is an article referring to the development of bronze-faced semi-steel castings which will be of considerable interest to railroad men, especially those who have to do with the maintainance of locomotive parts subject to wear. A foundry company in the Middle West, specializing in the manufacture of castings for railroad uses, has developed bronze-faced, semi-steel castings for which it is claimed that the bronze faces are 30 per cent harder than ordinary bronze and the semi-steel backs about 50 per cent stronger than grey iron. The possible uses of castings of this description are too many for enumeration but the first castings made and tried out were for driving box shoes and wedges, than which no parts of a locomotive are subject to greater use and abuse, wear and tear. The combination of durable wearing surfaces and strong backs provided qualities particularly valuable in shoes and wedges and it is stated that extensive tests over a period of 16 months showed the bronze-faced semi-steel shoes and wedges to be fully up to the claims made for them. During the test period, the entire shoe and wedge problem was studied from every angle including the possibilities of reclaiming the bronze after use. In view of the possible reduction in maintenance costs, further developments in the use of bronze-faced semi-steel castings for locomotive parts subject to severe stress and wear will be followed with great interest by railroad shop men.

Henry Ford on Car Design

Henry Ford's venture into the transportation business promises to be one of the most interesting developments that the railroad world has seen for some time. As a manufacturer, Mr. Ford has been remarkably successful, and even though he is not a railroad man, his opinion on the design of rolling stock cannot be disregarded, in view of his acknowledged ability in mechanical matters. Recently Mr. Ford made a few comments on car design, which are published elsewhere in this issue. His first criticism is that cars are too heavy. This has been a debated subject for at least 50 years, so it will be interesting indeed to see whether the automobile manufacturer will develop some highly original solution of the problem that railroad men have failed to grasp.

In some of the latest high-capacity cars the load amounts to 79 per cent of the total weight. It is hard to see how this ratio can be improved very much without lessening the strength of the car, thus sacrificing the operating advantages of powerful locomotives and long trains. In box cars the weight of the car forms a much larger proportion of the total under average loading conditions, but these cars must be strong enough to withstand the stresses set up by loads

of lumber, grain and other heavy commodities. Light cars have been tried by a number of roads but the saving in the cost of operation was not enough to offset the additional expense for repairs. Mr. Ford will indeed be a benefactor if he can show the railroads how to make a car light in weight without sacrificing strength or durability. Mr. Ford's new design of car axle should furnish a good test for his theories. It would seem that an appreciable saving in weight could only be obtained at the expense of added complication. If a lighter design can be developed that will not be more expensive to build or maintain than the present type, one of the oldest M.C.B. standards will have to be discarded.

In the mind of the general public the name of Henry Ford is a synonym for efficiency in business. On the other hand, rightly or wrongly, there is a general belief that the methods in use by the railroads are very inefficient. It is not unusual to hear the statement that any competent business man could operate the railroads more economically than the men who are now in charge. Perhaps Mr. Ford will prove that there is some foundation for this belief, but it is more probable that when his ideas are thoroughly tried out, they will vindicate the judgment of the men who have made the mechanical equipment of the railroads what it is today.

The Reintroduction of Piecework

Now that the Labor Board has modified the working rules for shop employees to provide for payment on a piecework basis, it is probable that many roads on which this system was in effect prior to federal control will again adopt it. The present wage scale is certainly deficient in failing to reward the efficient and diligent workman for his high production. The most important advantage of piecework lies in the fact that it provides a powerful incentive for personal efficiency by basing payment on results.

The flexible wage scale which piece work affords is a direct benefit to the worker but it also has very real advantages for the employer. The best mechanics, realizing that their services are worth more than the usual rate paid to the craft, almost always seek employment where their special output receives an extra reward. Therefore a flat rate would tend to drive out of railroad work the high-grade men who combine ability and ambition. Men of this type the railroads cannot afford to lose.

Probably piecework would not be justified solely for the purpose of retaining in the service men who might otherwise seek work elsewhere. But if the system is properly applied, it should bring about a considerable increase both in individual output and in the total production of the shop. The workers and the management are jointly responsible for this increase and they should share in the benefits. The company can reasonably expect a decrease in unit costs and the employee should receive a substantial increase in wages.

There has been just criticism of piecework in the past practically all of which was based fundamentally on the failure to divide the increased earnings due to piecework fairly between employer and employee. If piecework is to be a success under present conditions, the mistakes of the past must be avoided. Piecework rates should be established on the basis of a careful study of the job. Having set the price, the management should make it understood that so long as the method and the equipment are not changed, the price will not be altered except to make it conform to changes in the hourly wage scales. The practice of reducing rates if employees earn much over the average has a pernicious effect in arousing distrust of the piecework system and puts a check on production. The employer should recognize that high individual output decreases overhead and therefore the high-grade workman is worth all he can earn. The possibilities of piecework cannot be realized if it is not established on a basis of mutual confidence and fair play. Where both parties strive to make the system a success, there is no doubt that the employer and employee both can secure results that will amply justify the substitution of payment by results for the flat hourly rate.

Order vs. Disorder

Some men have a natural tendency to be systematic and orderly in all their work; others are just the reverse and never seem satisfied until everything is congested, both work and working implements being hopelessly mixed together regardless of the order in which they will be needed or used. Both extremes of order and disorder, together with all intermediate stages, may be found in railroad repair shops, and it is the purpose of this editorial to consider briefly the relation of orderliness to shop output, stating first our conclusion and then the reasons for it.

As with most problems in life, so with the question of orderly work; fortunate is the man or shop able to strike a "happy medium." It is perfectly possible to imagine a railroad shop where so much time is spent picking up and cleaning up and piling material to a hair line that practically no time is left for actual repair work. On the other hand, probably every reader has at some time or other visited a shop where the reverse is true. Machine tools and equipment are scattered everywhere, without regard to the sequence of operations. Unfinished machine parts, castings, flue racks, driving wheels, etc., are dropped on the floor wherever there is room, and it is difficult to get from one department to another on foot, to say nothing of operating trucks for the transportation of material. Congestion of this sort causes a serious delay in repairing and replacing locomotive and car parts; the additional manual labor involved in moving parts from place to place is costly; in some cases, material lying around on the floor is damaged and the repair work must be done over; and finally, it is always dangerous for men to work in a badly congested shop.

As a rule, it is more common to find a shop suffering from too little rather than too much order. The emphasis should be placed on order. In a particular case, where it is desired to make a shop more orderly, the question may be raised, how can this be accomplished. In the first place, the idea must be "sold" to the shop superintendent and foremen; in almost every well ordered shop it will be found that some one in authority makes a hobby of the subject. The second step is to group machines used in repairing each essential part, arranging these machines in the order of individual operations, thus eliminating back travel of material and parts. A third preparatory step is the establishment, and marking off, of wide passageways between machine groups and departments, these passageways to be kept clear at all times of machine parts, castings or material of any kind.

After obtaining the proper physical equipment and layout of machine tools, an effective shop schedule system should be installed, (1) to show the order in which each important locomotive or car part is needed, (2) to keep all parts moving, and (3) to show the reasons for delay, whether a weak department, lack of men, inability to get material or what not. But the shop schedule is too important a subject to be more than mentioned in the limited space available for this editorial. It will be discussed more in detail later.

As a final suggestion, it will undoubtedly pay in any medium sized shop to have one man do nothing but pick up material carelessly thrown around and clean out *all corners.* Experience has shown that this practice saves a large amount of material (often worth more than enough to pay for the man's wages) and, in addition, helps materially in increasing the morale of the workmen. Who is it that does not like to see a clean, orderly shop with everything moving in accordance with a well defined plan; storage platforms substantially made and arranged for the prompt locating of material; a

place for everything and everything in its place? The general idea of efficiency and effectiveness obtained in an orderly shop is not false and the effort and pains required to secure order are rewarded by a proportionate increase in shop output.

Progress in Boiler Design

In designing locomotive boilers it was formerly the practice to provide a grate large enough to burn the amount of coal theoretically required and then crowd into the shell of the boiler as much heating surface as possible. In recent years the high evaporative value of firebox heating surface has been demonstrated and the use of combustion chambers has become quite general. The improved performance due to the combustion chambers is clearly shown in the test of two locomotives of the same type and approximately equal weight. At the same rate of combustion the boiler with the combustion chamber gave approximately 20 per cent greater evaporation per pound of coal than the boiler without.

The exact length of tubes and combustion chamber to give the best results is difficult to determine. For example it was found in one case that a comparatively slight change in the design of the boiler, shortening the combustion chamber 15 in. and lengthening the tubes a like amount resulted in an increase in the evaporation per pound of coal ranging from 6.6 to 9.8 per cent.

The volume of the firebox and the gas area through the tubes are now recognized as important factors in determining the maximum rates of combustion and evaporation. Methods of improving the circulation of the water are coming into prominence and attention is being given to increased area of steam relieving service to avoid generating wet steam at high rates of evaporation. Great as the progress in boiler design has been there is still need for further investigation to enable engineers to formulate general rules for the most economical proportions of boilers.

Does Gas Cutting Always Pay?

Everyone concedes the important part played by the oxy-acetylene cutting torch, both in industrial and railroad shops, and should any doubts be entertained they will vanish on even a superficial inspection of the work done with it. Everywhere one goes parts are being manufactured, repaired, or reclaimed by the use of the cutting torch and at a saving of man hours, machine hours and physical effort.

One important point, however, should not be overlooked and that is the cost both for gas and labor. Recent tests have shown that a large proportion of the cost of gas cutting operations is for oxygen and that it costs anywhere from two dollars to five dollars an hour to operate a torch, depending upon whether light rivets or heavy steel sections are being cut. Obviously with this cost of operation, cutting torches must not be used indiscriminately either for cutting material of less value than the gas used, or material which can be more efficiently cut by machine. Moreover, there is a tendency for workmen to take every small cutting job to the oxy-acetylene table even when a slight physical effort would accomplish the same result at a lesser cost.

The possibility of cutting with the electric arc using a carbon electrode also should not be forgotten and, while comparative figures are not available undoubtedly there are occasions when cutting with the electric arc is more desirable from the standpoint of economy than cutting with the gas torch. This is particularly true when an ample supply of relatively cheap electric power is at hand.

Another method to be considered is cutting by mechanically operated gas torches; this is the subject of an article in this issue. The Radiagraph and similar types of machines for gas cutting on straight lines, circles and curves have demonstrated their value in cutting sheet metal and blanking out machine parts. They are used in industrial establishments and have been introduced to a certain extent in railroad shops. For steel car work, boiler shop work and certain operations on locomotive machine parts the mechanically operated cutting torch is an efficient tool and will save much money, particularly where conditions are such that the torch can be slowed down to give a smooth finished cut, obviating the need of subsequent machining.

The questions of what cutting apparatus to use, what material to cut and what not to cut can be solved only by an accurate knowledge of relative costs. In view of the possibilities of waste or economy, it would seem wise to have gas cutting operations under the direction of one man who will keep a record of labor, material and gas costs, thus being able to recommend in any particular case the most effective and economical cutting practice.

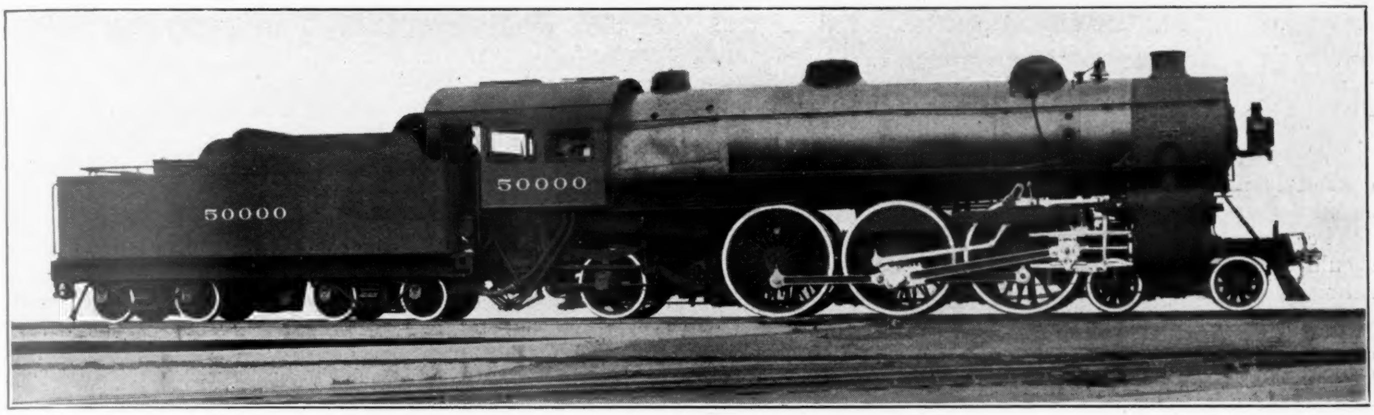
NEW BOOKS

Master Boiler Makers' Association Committee Reports. Edited by Harry D. Vought, secretary, 26 Cortlandt street, New York. 68 pages, 6 in. by 9 in. Bound in cloth.

This book contains the reports of committees on subjects prepared and filed for the thirteenth annual convention of the Master Boiler Makers' Association which was scheduled to be held at St. Louis May 23 to 26, 1921, but which was cancelled on account of the business conditions on the railroads. In place of the regular Official Proceedings it was decided by the Executive Committee to issue the committee reports which cover the following subjects:—Investigation of Autogenous Welding; Methods of Welding Safe Ends on Locomotive Tubes; Better Type of Crown Stay for Different Classes of Locomotives; Prevention of Deterioration of Fireboxes Behind Grate Bars; Causes of Boiler Shell Cracking Through Girth Seam Rivet Holes; Ways of Overcoming or Prolonging Time of Rupture; Best Type of Side Sheet; Oxy-Acetylene Welding; Electric Welding; and Advantages and Disadvantages of Treated Water.

Railroad Shop Practice. By Frank A. Stanley. 331 pages, 5 in. by 9 in. Bound in cloth. Published by McGraw Hill Book Company, New York.

The purpose of this book as outlined in the preface is to show typical methods and appliances adapted to the work of various repair shops. It contains 23 chapters, covering in a general way practically all phases of locomotive repair shop operation. Data for the preparation of the book was secured from railroads in various parts of the country and the methods shown, therefore, are not simply local. The description of methods is written primarily from the standpoint of general machine practice and in many cases the author shows lack of familiarity with general railroad shop methods. The author has given little consideration to the problem of repairs in its general aspect, but has treated each operation as practically unrelated to other work. Consequently, the book is more in the nature of a collection of shop kinks than a treatise on general shop practice. A very large portion of the entire book is devoted to machine shop practice, although short sections dealing with blacksmith shop, boiler shop and car department practice are included. Some of the methods described are probably the very best practice in their respective lines, but other methods included would be classed as obsolete in the majority of shops. The value of the book would have been increased if greater care had been taken to give each important division of railway shop work the attention which its relative importance would warrant and if more discrimination had been used in selecting the examples of shop practice described in the work.



Experimental Pacific Type No. 50000, Which Established New Records for Power per Unit of Weight

Avoidable Waste in Locomotive Operation as Affected by Design*

BY JAMES PARTINGTON
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IT SEEMS advisable to consider this subject from the constructive standpoint of indicating what constitutes good design as demonstrated by locomotives in actual service, rather than to attempt to point out the defects in locomotives which do not show maximum efficiency. If any power plant or engine is not properly proportioned for the work it has to do, the most expert skill in operation can reduce only in part the waste resulting from having such equipment in service.

First, considering the design of steam locomotives from the standpoint of new equipment, when a railroad company is in the market for new locomotives its requirements may be met sometimes by duplicating locomotives in service on their road, but adding newly developed attachments which make for increased efficiency and economy. More frequently, however, it will be found that increased traffic, change from wooden to steel cars, improvement in track, roadbed and bridges, etc., will justify and make advisable the adoption of locomotives of a larger and more powerful type.

Then careful consideration must be given to service requirements—maximum loads to be hauled, capacity of cars, approximate proportion of loaded to empty cars per train, grades, curves, running time over divisions, maximum allowable load per axle, location of coal chutes and water tanks, clearances, conditions under which trains must be started, and any other special requirements of the service.

Having determined the drawbar pull necessary, it remains to design a locomotive that will have the following efficiency requirements:

1. A drawbar horsepower for the minimum amount of fuel.
2. A drawbar horsepower for the minimum amount of weight of locomotive and tender.
3. A drawbar horsepower for the minimum cost of repairs.

Fuel Economy

As standard practice in modern locomotives, a sectional brick arch in the firebox and a fire-tube superheater should be applied as a means of saving fuel in any class of service. A sectional brick arch is low in first cost, easily applied and easily renewed. It usually accomplishes a fuel saving of from 10 to 12 per cent in coal-burning engines, and about 5 per cent in oil-burning engines.

The very general use of superheaters has gradually brought about improved conditions of cylinder lubrication which now make it possible and desirable for the greatest economy to use a high degree of superheat, 250 to 300 deg. F. now being considered the best practice. A saving of 25 to 30 per cent can be obtained.

The use of feedwater heaters will further conserve fuel, and these are now in general use in continental Europe and are gradually being applied to locomotives in the United States. The saving that can be realized is as much as 12 per cent. The initial cost is considerable, but the effect of the feedwater heater in operation, aside from fuel economy, will be to help reduce other boiler-maintenance charges.

The general proportions of the boiler should also receive careful consideration. For the best results with bituminous coal, the length of the boiler tubes should be approximately within the following limits:

Size of tube, in.	Distance over tube sheet
2	18 ft. 0 in. to 19 ft. 6 in.
2¼	22 ft. 6 in. to 24 ft. 6 in.
2½	28 ft. 0 in. to 30 ft. 0 in.

For many designs of locomotives, a combustion chamber can be provided, and this will help further in the economical production of steam. A generous steam space should be provided, and the throttle designed and located to secure dry steam. The evaporative capacity of the boiler should be as nearly 100 per cent of the maximum steam requirements of the cylinders as the type of locomotive will permit. Based on 100-per cent boiler, the grate area should be sufficient to prevent the maximum coal consumption per sq. ft. of grate per hour from exceeding, for bituminous coal, 120 lb., and for anthracite coal, 55 to 70 lb., depending on size.

When the total coal consumption exceeds 6000 lb. per hr., it is generally necessary to apply an automatic stoker. These have now been so adapted to locomotive requirements that a properly designed stoker will show economy over hand firing, aside from the necessity of its use on account of the coal consumption being greater than the physical capacity of one fireman if the boiler were hand-fired.

The arrangement of deflector plates and netting in the

*A paper to be presented at the meeting of the Railroad Division of the American Society of Mechanical Engineers, New York, December 9.

smoke-box should be carefully adapted to the fuel and combustion conditions, to provide minimum fuel waste and minimum back pressure in the cylinder-exhaust passages with proper provision against fire hazards which might obtain by the throwing of sparks.

The boiler being designed to produce steam at a minimum cost, it is now necessary to design the engine to use this steam with maximum economy.

The cylinder proportions and diameter of the drivers should be such as will develop maximum horsepower at the ruling speeds for train movements. The greatest horsepower of locomotive cylinders will usually be developed within a piston speed ranging from 700 to 1000 ft. per min. Therefore, if other traffic conditions will permit, the operation of trains within these limits should show the greatest operating economy.

Minimum Weight of Motive-Power Equipment

The weight on the locomotive drivers gives an engine friction, independent of other factors, of 22 lb. per ton. The desirability of avoiding excess weight on the drivers from this standpoint alone is therefore readily apparent. When the type of engine will permit, this weight should not exceed what is necessary to give a satisfactory factor of adhesion; this is usually 4¼ times the maximum tractive power. All weight in excess of this and all other excess weight and excess tender weight should be eliminated, as far as this can be done without detriment to the design of engine and tender. This applies with particular force to the machinery parts of the engine, especially those parts which affect the counterbalance. All saving in weight in these parts usually produces a similar saving in counterbalance weights and a reduction in the dynamic augment, which is very desirable from the standpoint of track and roadbed maintenance.

The use of special materials to keep down weight is often amply justified if repair parts can be obtained promptly when required. This, in the past, has often been the cause of delay, but it can be guarded against by carrying a few spare parts in stock ready for renewals. High-tensile alloy steel can frequently be used to advantage for driving axles, crank pins, main and side rods, piston rods, etc.

Occasional steep grades or hard starting conditions at stations may cut down the hauling capacity of locomotives over a division to a serious extent. In such cases, the utilization of the weight on trailer trucks for additional tractive power in starting and at slow speeds may increase the capacity of the locomotive from 10 to 25 per cent, depending on the number of driving wheels and working pressure. It has been demonstrated that a separate steam engine or booster geared to the trailing axle will give this additional traction, and that it can be cut in or cut out very satisfactorily as occasion may require.

This is an item in economical operation worthy of consideration where hauling capacity is restricted by such limitations, and the use of an independent booster may often permit the satisfactory operation of considerably lighter locomotives for service of this character.

Within the limits of this paper, only the major features of design can be outlined briefly, and only such devices as have been carefully tried out and are in successful operation are cited. The writer believes the savings mentioned are well within what may be obtained in practice.

Many other improvements promising further economy in the generation and use of power in the steam locomotive are contemplated and are now in the experimental stage, but these do not properly come under the scope of our subject as here treated.

Cost of Repairs

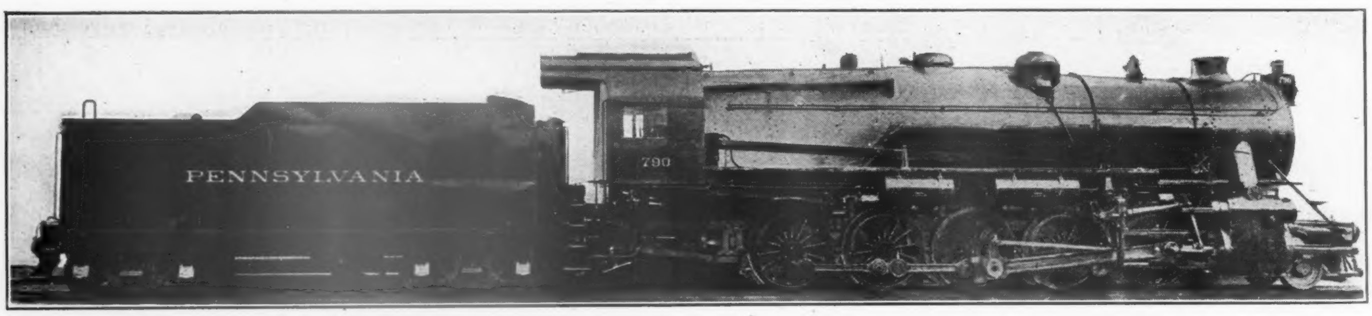
It has been pointed out that locomotives and tenders should be designed to produce the required drawbar horsepower with as little excess weight as possible. In this connection, however, due consideration must be given to the question of repairs.

The design of boilers from the standpoint of weight is practically fixed by existing boiler regulations, which provide that locomotive boilers must be operated with a factor of safety of not less than four. Practically all boilers at the present time are designed with a factor of safety of 4½, which leaves a comfortable margin between this and the minimum allowable operating factor.

The maximum stresses in other parts of the locomotive must also be carefully considered, and the parts must be designed to keep these stresses within limits which will eliminate costly failures in service.

Aside from the consideration of stresses, much repair cost can be avoided by adopting designs which reduce the number of parts, as far as reasonably may be, especially where these parts must have bolted connections. Here, however, care must be taken to avoid construction which cannot readily be removed for repairs or renewals or repaired in place with reasonable facility.

Many roads today are giving a great deal of thought to locomotive design along these lines, having especially in mind the desirability of making the engine parts accessible for oiling and inspection; easily removable with proper shop facilities; of the minimum number of pieces and interchangeable with equipment now in service.



Pennsylvania Decapod With Short Maximum Cut-Off, Which Shows Remarkable Economy Over a Wide Range

The repair-shop facilities must, of course, be kept abreast of the requirements; *i.e.*, as new and larger locomotives are put in service, turntables, cranes, machine tools, etc. must be of sufficient capacity to handle the larger equipment economically.

The repairs of locomotives can often be facilitated and the necessary shop equipment kept down to the minimum by securing from the locomotive builder many parts which he is able to turn out more accurately and more economically than the average railroad shop would be equipped to do. Such parts include: flanged sheets for boiler repairs; flexible and ordinary staybolts; finished bolts and nuts; drop forgings; packing rings for pistons and piston valves and

special equipment which requires special tools for its production.

Without attempting to pursue further the design of new locomotives it may be remarked that a study of the special conditions of individual railroads is necessary to secure equipment best suited to the needs of each.

Old Motive-Power Equipment

Much waste in locomotive operation can be avoided by making a careful survey of present motive-power equipment which is not giving as economical or efficient service as could be obtained if the engines were modernized. This applies particularly to locomotives where the service conditions demand more power than the present equipment can economically produce. All the suggestions made in regard to the design of new equipment are applicable to a greater or less degree to old equipment, providing the old equipment is not meeting the demands of the service from a power standpoint, or is not furnishing this power economically.

In making a survey of this character care should be taken to determine accurately whether the old equipment will warrant the additional cost of changes and betterments necessary to convert it into up-to-date power. This can be decided by taking the number of years the engines will be retained in service and the increased net return or saving for this period as against the cost involved for changes, interest on the additional investment, increased maintenance, etc.

A comparison should also be made with the results that could be realized by the purchase of new equipment best adapted for the service, as against the cost of contemplated changes in the old equipment. If these comparisons show a saving in favor of modernizing the old equipment or the purchase of new equipment, every month that the engines are kept in service without doing this will result in a loss that is not recoverable.

A few concrete examples of what has been accomplished in service by locomotives designed to yield maximum efficiency may be of advantage. Notable designs, for which data is available, are as follows:

Pacific type passenger locomotive No. 50000 built by the American Locomotive Company; Decapod type freight locomotive, Class I1s, built by the Pennsylvania Railroad and heavy Mallet special service locomotive built for the Virginian by the American Locomotive Company.

American Locomotive Company Engine No. 50000

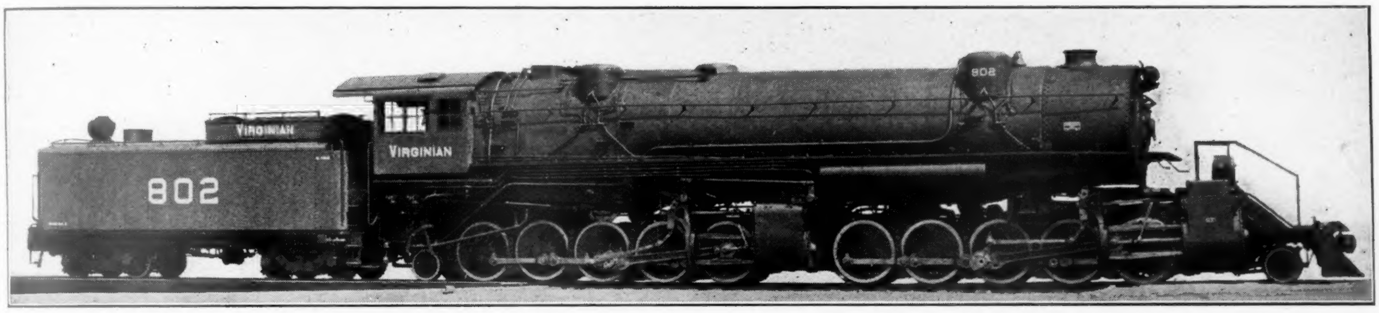
Locomotive 50000 was built by the American Locomotive Company in 1910. It was designed and constructed at the builder's expense to demonstrate the maximum tractive power with adequate boiler capacity that could be obtained while keeping the adhesive weight below 60,000 lb. per driving axle.

Untrammeled by any outside specifications or the necessity of conforming to any railroad's existing standards, the builders had a free hand to embody in this design their ideas of the best engineering practice. To accomplish the purpose of the design—the maximum capacity per pound of weight—the largest boiler capacity within the predetermined wheel loads was the essential feature.

This end was obtained by eliminating every pound of weight in all the parts that was not necessary to strength and durability, utilizing the weight thus saved to provide a larger boiler, and by increasing the capacity of the boiler thus secured by combining in one design the most approved fuel saving devices to obtain the utmost economy in boiler and cylinder performance.

Many of the large Pacific type locomotives with drivers 75 in. in diameter and over in operation today greatly exceed locomotive 50000 in total weight.

An average of all of the important engines of this type including locomotive 50000 shows approximately 1,000 lb. less tractive power with an increase of 17,400 lb. in weight with the very slight advantage of only 1½ per cent in boiler capacity. (See table appended).



Virginian 2-10-10-2 Type, the Most Powerful Locomotive in the World

Locomotive 50000 delivers one cylinder horse power for every 110.8 lb. of weight and one boiler horse power for every 120.3 lb. of weight.

In actual tests it developed:

An average rate of 2.21 lb. of coal per i.h.p. hour.

A low rate on one test of 2.12 lb. of coal per i.h.p. hour.

An average rate of 16.85 lb. of steam per i.h.p. hour.

A low rate on one test of 16.5 lb. of steam per i.h.p. hour.

A maximum indicated horse power of 2,216 or one horse power for every 121.4 lb. of weight.

The thought occurred that possibly 50000 was built too light and that later on, in order to keep the engine in service, many of the parts might require strengthening.

Locomotive 50000 was purchased by the Erie Railroad and numbered 2509. Wm. Schlafge, Mechanical Manager of the Erie, states that since the locomotive was received it has been necessary to make very few changes. The guide yoke was reinforced on account of working. Guide yoke blocks were also made solid on the guide yokes. The trailer spring sliding block was changed to the same type as used on the railroad's K-4 Pacific type locomotives. No other changes or alterations have been made. Yet from the time this locomotive was placed in service on the Erie up to March 1, 1920, it had made a total mileage of 351,800.

Ten years of service coupled with 350,000 miles of running demonstrate the strength of the design and the figures given indicate remarkable performance.

Pennsylvania Railroad Class I 1s

While the design of engine 50000 represents the best practice of the present day as measured by the economical operation of passenger locomotives, the development of heavy freight power involves the consideration of other factors that materially affect the design. In 1915 the Pennsylvania Railroad found that for the economical operation of their line a tractive power about 25 per cent in excess of the Mikados then in use was desirable. In working on the design for such an engine, an attempt was made to obtain

better economy in performance by a radical departure in cylinder proportions. The accepted practice in proportioning cylinders is to arrange for a cut off of nearly 90 per cent of the stroke, so that the starting torque may be as uniform as possible.

As the adhesive weight limits the cylinder diameter if excessive slipping is to be avoided, it is obvious that on long grades, where the maximum tractive effort is required, the long cut offs use steam in a most uneconomical manner. As the Pennsylvania has several such long grades on its line, the new design adopted involved a limitation of the cut off to about 50 per cent in place of 90 per cent and an increase in the cylinder diameter to give sufficient torque at this cut off to fully utilize the adhesive weight. The expected increase in economy of coal and water due to the shorter cut off has been fully realized. Not only has the engine shown remarkable efficiency, but the economy under wide ranges of load is especially remarkable.

We are fortunate in having available a very complete test of this engine, made on the testing plant at Altoona. (Bulletin 31, P. R. R. Testing Plant 1919, copyrighted). This test shows a water rate of 15.4 lb. per i.h.p. hour with a total i.h.p. of 3,080 at 40 per cent cut off and a coal consumption 2.9 lb. The lowest coal consumption recorded is 2.00 lb. per i.h.p. hour, obtained at an output of 1,777 i.h.p. and a cut off of 30 per cent.

The thermal efficiency of the locomotive is also high and well sustained over a large range, a maximum of 8.1 per cent being attained at an output of 1,777 i.h.p., and the range being from 6.1 per cent at 776 i.h.p. to 5.3 per cent at 3,486 i.h.p. with an average of over 7 per cent for the usual operating conditions.

The highest drawbar pull recorded in these tests is 76,211 lb. at a speed of 7.4 m.p.h., but in road service a pull of 80,640 lb. has been recorded at 7.2 m.p.h. The indicated tractive effort plotted from a card taken at 7.4 miles per hour at 55 per cent cut off is slightly over 90,000 lb.

This design gives a calculated figure of 88.9 lb. per cylinder horse power, the lowest on record. During the tests an indicated horse power of 3,486 was developed, giving a weight of 106.2 lb. per horse power. The weight per boiler horse power does not compare as favorably, however, as it is 145.4 lb. The Belpaire firebox contributes materially to this excess.

Virginian 2-10-10-2 Type Locomotives

The large 2-10-10-2 Mallet engines for the Virginian were designed to meet their unique conditions. This road was built as an outlet to certain bituminous coal fields of West Virginia. Practically the entire revenue business is confined to hauling coal to the shipping docks at Sewall's Point, the west-bound revenue freight being negligible in amount, as only one town of any importance, Roanoke, is located on the line. As the development of the coal fields proceeded the tonnage to be handled increased rapidly, rising from 2,141,009 in 1911 to 7,621,555 in 1920, and in order to handle the business at a profit the maximum attainable capacity in motive power was demanded. Having fixed on 100 cars as the maximum number that could safely be handled in a single train, the car capacity increased to 120 tons, it was estimated that a locomotive of 147,000 lb. tractive power would be needed to haul the train from Princeton to tidewater, a helper being used for a grade of .6 per cent ten miles long over the Alleghenies. The 2-10-10-2 Mallets were designed to meet these conditions and their operation has been very successful. They have handled trains of 16,000 tons on a .2 per cent grade with the lowest consumption of coal per ton mile ever recorded. Unfortunately, accurate tests of coal and water per dynamometer horse power are not available owing to the fact that there is no dynamometer of adequate capacity to be had at present. However, on May

LARGE PACIFIC TYPE LOCOMOTIVES NOW IN OPERATION IN THE UNITED STATES

Engine	50,000												Average
Cylinders	27 in. by 28 in.	27 in. by 28 in.	25 in. by 28 in.	25 in. by 30 in.	27 in. by 28 in.	26 in. by 28 in.	26 in. by 28 in.	23½ in. by 26 in.	26 in. by 28 in.	25 in. by 28 in.	25 in. by 28 in.	25 in. by 28 in.	25.6 in. by 28 in.
Drivers—dia.	79	80	79	75	77	79	75	79	75	77	80	75	77.5
Boiler—dia.	76⅜	78½	76¾	79⅞	75 1/16	78	78 9/16	70⅝	76	74	72	69	....
Pressure	185	205	210	200	185	210	200	200	190	200	200	185	197.5
Firebox, length	114⅛	126	126	111⅛	114 1/16	126⅛	114⅝	108⅛	110	120⅝	126¼	108⅛	....
Firebox, width	75¼	89	108¾	84⅜	84	108¾	84¼	75¼	72	84	108¾	70¼	....
Tube, length	22-0	19-0	17-3	18-6	22-0	19-0	20-6	21-6	20-0	22-0	19-0	20-0	....
Wheel base driving	14-0	13-10	14-0	13-2	14-0	13-10	13-0	14-0	13-0	13-4	13-10	13-6	....
Wheel base engine	35-7	36-6	36-0	34-9	36-2	35-8	34-11	36-6	34-4	35-8	35-7	34-9	....
Weight on drivers	172,500	201,800	192,500	181,500	178,000	181,400	194,000	184,500	169,500	165,000	176,900	168,500	180,500
Weight of engine	269,000	308,900	302,000	299,000	295,000	291,400	287,000	282,000	280,000	279,500	273,600	269,000	286,400
Heat. surf. tubes and flues	3,808	3,746.8	2,830	3,232	3,534.7	3,454	3,939	3,193	3,386	3,720.9	2,644	2,970	....
Heat. surf. firebox	248	288.6	351	297.6	239.8	303	259.6	231	240	266.4	282	230	....
Heat. surf. total	4,056	4,035.4	3,181	3,529.6	3,774.5	3,757	4,198.6	3,424	3,620	3,987.3	2,926	3,200	3,640.8
Superheating surface	897	1,154	645	803	962	816	970	838	830	783.5	652	778	....
Grate area	59.8	70.0	95.0	65.0	66.5	94.8	67	56.5	55	70.4	94.5	52.7	{ 61.6* 70.6
Tractive power	40,600	41,845	39,500	42,600	41,700	42,770	42,900	30,900	40,700	38,600	37,200	36,700	39,670
Cyl. h.p.	2,427	2,690	2,365	2,252	2,427	2,556	2,434	1,990	2,312	2,252	2,252	2,083	2,336
Boiler h.p.	2,235	2,467	2,244	2,282	2,104	2,311	2,398	1,958	2,112	2,267	1,950	1,869	2,186
Weight per cyl. h.p.	110.8	114.8	127.7	132.8	121.5	114.0	117.9	141.7	121.1	124.1	121.5	129.1	122.8
Weight per boiler h.p.	120.3	125.2	134.6	131.4	140.2	126.1	119.7	144.0	132.6	123.3	140.3	143.9	131.8
Boiler percentage	92.0	91.7	95.0	101.0	86.7	90.5	98.5	98.2	91.5	109.5	86.8	90.0	93.5

*Is an average of the soft coal burning engine only. The figure 70.6 is the average for all the engines, including the hard coal burners.

25, a train of 15,725 tons behind the tender was hauled from Princeton to Roanoke at a rate of 26.9 lb. of coal per 1,000 ton miles, and on May 27 a 75 car train of 12,070 tons showed the same figure for coal per thousand ton miles.

One of these engines has hauled a train of 110 cars weighing 17,250 tons from Victoria to Sewall's Point, which is believed to be the heaviest train ever handled by one engine. The ruling adverse grade was .2 per cent.

The principal dimensions of the three locomotives cited and a comparison of the horse power characteristics—calculated by the American Locomotive Company's method—are embodied in the following table:

MODERN MAXIMUM EFFICIENCY LOCOMOTIVES

	No. 50000		
Road	Erie	Virginian	Pennsylvania
Type	4-6-2	2-10-10-2	2-10-0
Fuel	Bituminous coal	Bituminous coal	Bituminous coal
Boiler, type	Conical connection	Extended wagon top	Conical connection
Boiler, diameter	76¼ in.-87 in.	105½-118½ in.	87-90½ in.
Weight on drivers, lb.	172,500	617,000	342,050
Weight on truck, lb.	49,000	32,000	29,750
Weight on trailer, lb.	47,000	35,000	....
Weight, total, lb.	269,000	684,000	371,800
Driving wheel diam.	79 in.	56 in.	62 in.
Cylinders	27 in. by 28 in.	30 in. and 48 in. by 32 in.	30½ in. by 32 in.
Boiler pressure, lb. per sq. in.	185	215	250
Tractive power, lb.	40,600	147,200	90,000
Factor of adhesion	4.25	4.08	3.80
Cylinder horse power	2,427	5,040	4,182
Grate, length and width.	114 in. by 75¼ in.	144 in. by 108¼ in.	126 in. by 80 in..
Grate area, sq. ft.	59.7	108.7	70.01
Tubes, number	207	381	244
Tubes, length	22 ft. 0 in.	25 ft. 0 in.	19 ft. 1 in.
Tubes, spacing	¾ in.	⅞ in.	⅝ in.
Tubes, thickness	No. 11 B. W. G.	No. 11 B. W. G.	.125
Tubes, diameter	2¼ in.	2¼ in.	2¼ in.
Flues, number	36	70	48
Flues, diameter	5½ in.	5½ in.	5½ in.
Flues, thickness	3/16 in.	No. 9 B.W.G.	.18
Combustion chamber—length.	None	36 in.	42 in.
Brick arch	Security	Gaines	Security
Heating surface—firebox, sq. ft.	248	532	290
Heating surface tubes—water side, sq. ft.	2,672	5,592	2,731
Heating surface flues—water side, sq. ft.	1,136	2,511	1,313
Heating surface total, sq. ft.	4,056	8,635	4,334
Boiler horse power	2,250	4,800	2,553
Steam rate, lb. per hp. hour.	20.8	19.7	20.8
Coal rate, lb. per hp. hour.	3.25	3.1	3.25
Superheater, number of units.	36	70	42
Superheater, diameter	1½ in.	1½ in.	1½ in.
Superheater, heating surface.	879	2,120	1,418
Tender weight in running order, lb.	161,500	214,300	182,000
Tender capacity coal, tons.	14	12	17½
Tender capacity water, gallons.	8,000	13,000	9,000
Weight of locomotive in lb. per cylinder hp.	110.6	135.7	88.9
Weight of locomotive in lb. per boiler hp.	119.6	142.5	145.4
Best actual performance—			
Steam rate—lb. per hp. hour.	16.5	....	15.4
Coal rate—lb. per hp. hour.	2.12	....	2.0

Drop Pits at Terminals on the South African Railways

BY JOHN D. ROGERS*

The question of drop pit facilities should receive the most careful consideration of American railway motive power officers who at this time are striving to reduce costs of operation and increase the earning capacity of locomotives. The practice of jacking engines for replacing wheels is as obsolete as the tallow candle, yet it still prevails at many terminals. Modern motive power represents enormous invested capital, in addition to which heavy overhead charges are accruing whether the engine is idle or in service. Railway executives should heed the recommendations of their motive power officers for improved facilities, one of the most important of which should be efficient drop pit arrangements. The engineering and motive power departments should co-operate when terminal plans are prepared. There should be no difference of opinion concerning the advantages of drop pits—the principal feature to be considered is the number and arrangement. Drop pits inconveniently placed will often cause delays in the turning of power and compel the roundhouse foreman to "take a chance," the risk of which is too well known for comment here.

It may seem strange to the American railway man to have his attention called to South Africa for an illustration of what has been accomplished in equipping engine terminals with drop pits. The writer had many years' experience in

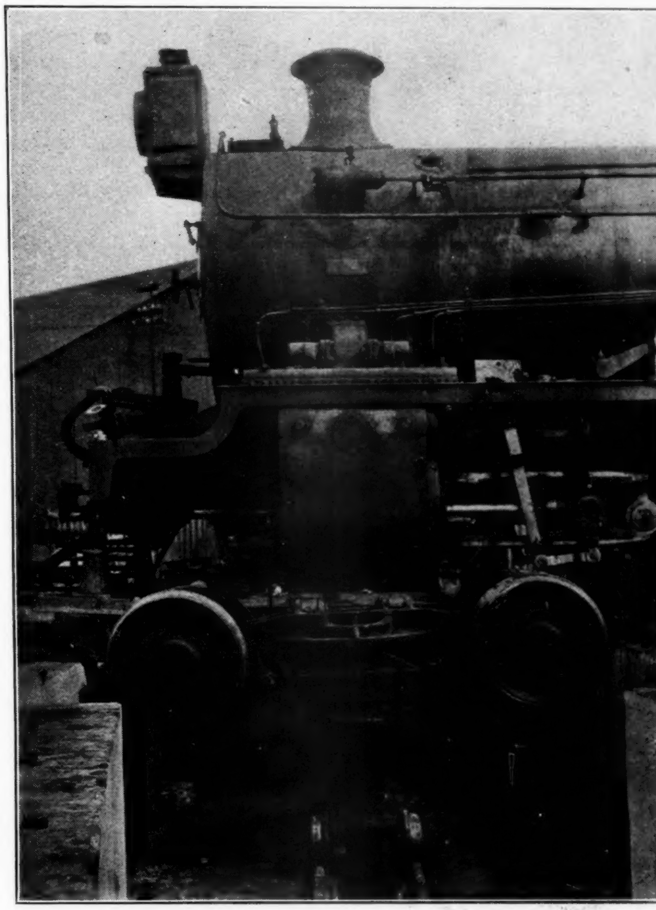


Fig. 1—Engine Truck Drop Pit at Bloemfontein

operating roundhouses on some of the important American railways and has in mind many terminals where today the heaviest engines are jacked to a critical height to run out the truck for changing wheels or other repairs; in addition to the excessive loss of time serious damage often results to the engine frame and spring rigging. Practically every terminal on the South African Railways, including those on the outlying districts, is equipped with modern drop pits for truck and driving wheels. These pits are invariably arranged to give the most flexible service for all wheels, including those of the tender. All pits are equipped with an efficient hydraulic jack which is manufactured by the railway company in its shops at Uitenhage.

Pits are always clean and dry; they are constructed of concrete, the walls being whitewashed. The question of drainage has been given most careful attention as many of the pits are in the open and South African rainfalls are ex-

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tremely heavy. With the facilities existing on the South African Railways, the dropping of wheels is considered a routine job, and causes no more concern than packing a piston. Incidentally the number of wheels dropped for hot driving boxes is somewhat in excess of American practice.

In Fig. 1 is shown a drop pit at Bloemfontein, which is one of the most important terminals on the South African railway. The general arrangement is representative of the design for engine and tender trucks. It is 11 ft. wide and permits of reversing the truck without removing it from the pit, a very convenient means of putting sharp flanges behind. When the pit is not in use, the rails are supported by removable columns which fit into a socket in the bottom of the pit. Driving wheels drop pits are always provided, but are seldom used for other wheels, as they are generally blocked by engines undergoing more or less heavy repairs.

The standard drop pit for car wheels is shown in Fig. 2. All yards where wheels are changed have such a pit. The number of tracks served depends on the importance of the terminal. In some cases three or four tracks span a pit. Wheel storage tracks are provided adjacent to those on which the cars are placed.

This concentration of wheel replacement makes the absence of wheels scattered throughout the yards particularly noticeable. Regular wheel gangs are employed; no time is lost in transferring jacks and making a suitable foundation.

Fig. 2.—In South Africa Drop Pits Are Provided for Changing Wheels on Freight Cars

A small shed, provided with benches and vises together with an assortment of tools, is located near the pit. Spare brasses and boxes are kept on hand, also some packing box "dope."

The platform drop pit shown in Fig 3 is located at Germiston, and was manufactured locally of such material as was available. The six inch vertical screw, *A*, is supported in the carriage by a brass nut. The nut is driven by a reversible air motor directly connected to a worm driving the gear wheel, *B*. The jack is traversed in the pit by the hand wheel, *C*, geared to one of the axles of the carriage.

The minimum time required for raising or lowering the table is approximately two minutes. The lifting capacity is about 20 tons. This is sufficient to raise the end of an empty car high enough to catch the body on jacks, thereby eliminating the time lost in jacking the car. This pit can be used for replacing either a complete truck or a single pair of wheels. Spare trucks of different classes are kept on hand. This is especially advantageous when a truck requires extensive repair, as the car can be returned to service immediately. This feature offers an opportunity to increase car mileage, which must be recognized as the unit of a railway's earning capacity.

Many of the American railways have modern and elaborate facilities for changing wheels on rolling stock. This equipment includes high capacity cranes for lifting cars and

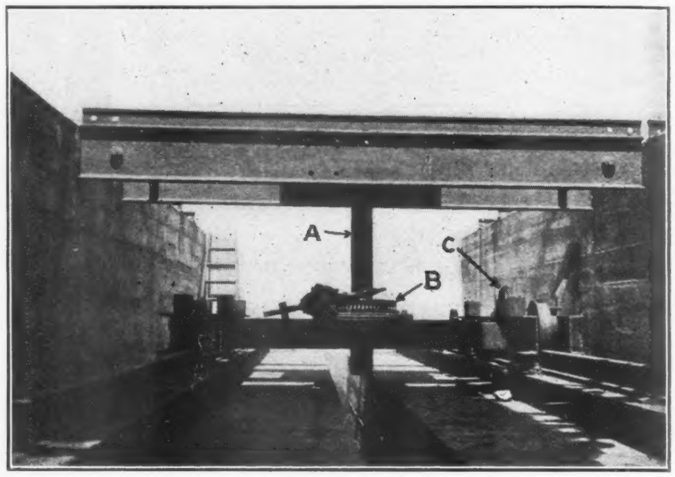


Fig. 3.—A Home-Made Drop Table of 20 Tons Capacity

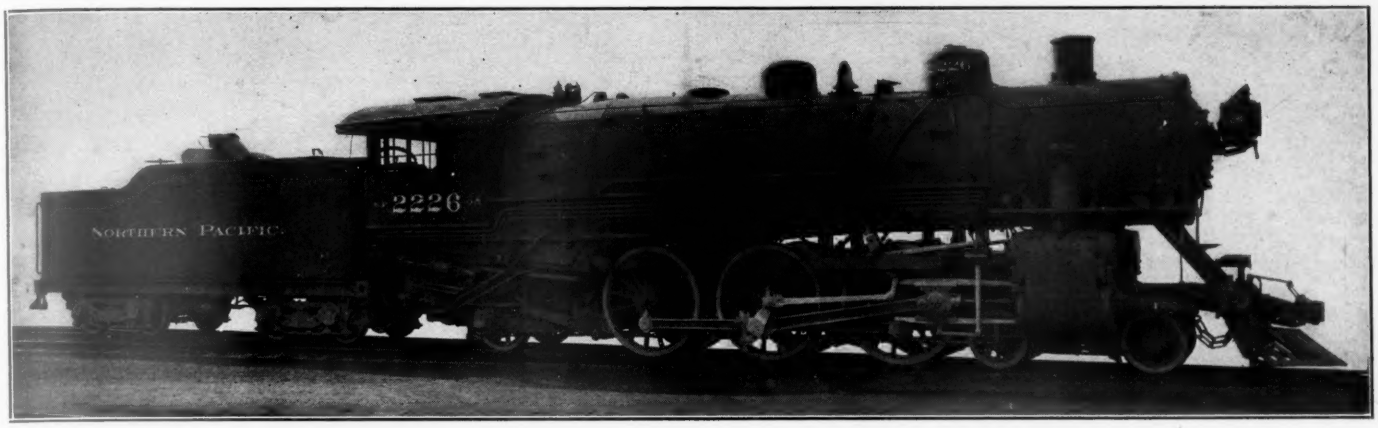
trucks. The extensive introduction of such facilities is limited by the fact that in the majority of terminals the first cost is not justified by the saving in operating expenses. It is evident, therefore, that the only alternative is the drop pit.

The Three-Cylinder Locomotive

The three-cylinder type of locomotive has not been received with favor in this country, although it has occasionally been tried. In some of the two-cylinder locomotives now being built the power is limited by the size of the cylinders that can be applied without exceeding the roadway clearance and the three-cylinder type is often suggested.

British railroads have used three-cylinder locomotives to a considerable extent and they are very favorably regarded as is evidenced by these comments from the Railway Gazette:

"For various reasons, based inherently on principle, although largely, of course, dependent upon individual practice and design, the three-cylinder locomotive has proved itself to possess certain decided advantages as compared with equally powerful two-cylinder types. We refer more particularly in this connection to the three-cylinder simple arrangement, such as is used for several different classes of locomotives on leading main lines in this country. First, there is the superior balancing of the engine, which has the effect of adding to the smoothness of its running, and what is equally important reducing the stress upon the track, so that it would appear to be quite possible to utilize a heavier three-cylinder locomotive, having cranks at 120 deg., than a two-cylinder one with cranks at 90 deg. on track where it is necessary to study very carefully the axle loads and total weight of the locomotives employed. Another point is that, owing to the fact of there being six cylinder exhausts to each complete turn of the driving wheels instead of four, a much more even and favorable draught effect is produced upon the fire, thus aiding combustion and as a natural consequence the production of steam. Thus, with its superior torque and more favorable draught conditions, the three-cylinder engine may be expected to come into greater prominence, particularly where the locomotive and track conditions create a difficult problem."



Heavy Pacific Type Handles 12 Passenger Cars cr More Over the Rocky Mountains

New Locomotives for the Northern Pacific

Pacific Type for Heavy Fast Service—Mikados, Mallets and Switchers Follow Lines of Earlier Designs

THE Northern Pacific placed one of the largest orders for locomotives given in 1920. This consisted of 20 eight-wheel switchers (0-8-0 type), 20 Pacific (4-6-2 type), 25 Mikado (2-8-2 type) and 6 Mallets (2-8-8-2 type), all of which were built by the American Locomotive Company at the Brooks plant.

Pacific Type

The Pacific type locomotives, railroad Class Q-5, are of a new design developed to meet the need for a heavier fast passenger engine to haul the overload trains. They have been assigned to all divisions between Dilworth, Minn., and Missoula, Mont. The profile on these divisions varies from comparatively level to grades of 2.3 per cent, which occur in the Rocky Mountains, with curves up to 16 deg. The average train consists of 12 cars, although in the summer season the number occasionally reaches as high as 17. The majority of these locomotives operate over two divisions or sub-divisions of about 110 miles each, crews being changed at the end of each sub-division. In other cases the locomotives are assigned to the heaviest runs in such a way that they double the sub-division each day, there being in such cases either two crews assigned to each engine or three crews to two engines.

These Pacific type locomotives have a rated tractive effort of 41,900 lb. with 26 in. by 28 in. cylinders, and 73 in. driving wheels and weigh 314,000 lb., of which 181,000 lb. is on the drivers. They have boilers of the conical connection type with wide firebox, combustion chamber 39 in. long, tubes 18 ft. long, brick arch and superheater. The tenders are equipped with coal pushers.

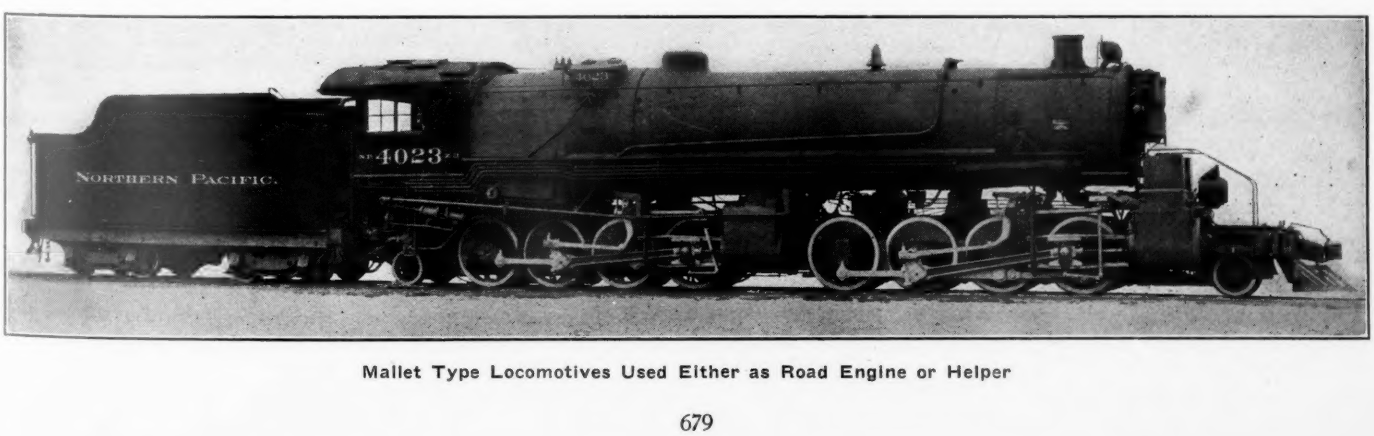
Mikado Type

The Mikado type locomotives, railroad Class W-3, are similar in design to previous locomotives which have been found to be well suited to general traffic conditions on the Northern Pacific. They are used in main line freight service on several divisions having profiles of different characteristics. On the Pasco division they run 153 miles, 90 miles of which is a 0.4 per cent continuous grade, and handle trains of 3,200 tons. The Yellowstone division profile between Mandan, N. D., and Glendive, Mont., is a series of ascending and descending grades, with ruling grades of 1.2 per cent both eastward and westward. The rating on this division is 1,775 tons in both directions. On the Seattle division between Auburn and Lester, Wash., a fairly uniform 1.0 per cent grade occurs, and the tonnage rating for this portion of the division is 1,600 tons. From Lester to the summit helpers are used and they are also employed on several other divisions in the mountainous sections.

These Mikado type locomotives have a rated tractive effort of 57,100 lb.; 28 in. by 30 in. cylinders and 63 in. driving wheels, and weigh 337,000 lb., of which 247,000 lb. is on the drivers. The boilers are of the conical connection type, provided with brick arches, combustion chambers 36 in. long, tubes 18 ft. long and superheaters.

Mallet Type

The Mallet type locomotives, railroad Class Z-3, are similar to previous 2-8-8-2 locomotives used on the Northern Pacific. They are employed as helpers in freight service on the Rocky Mountain and Montana divisions where grades are



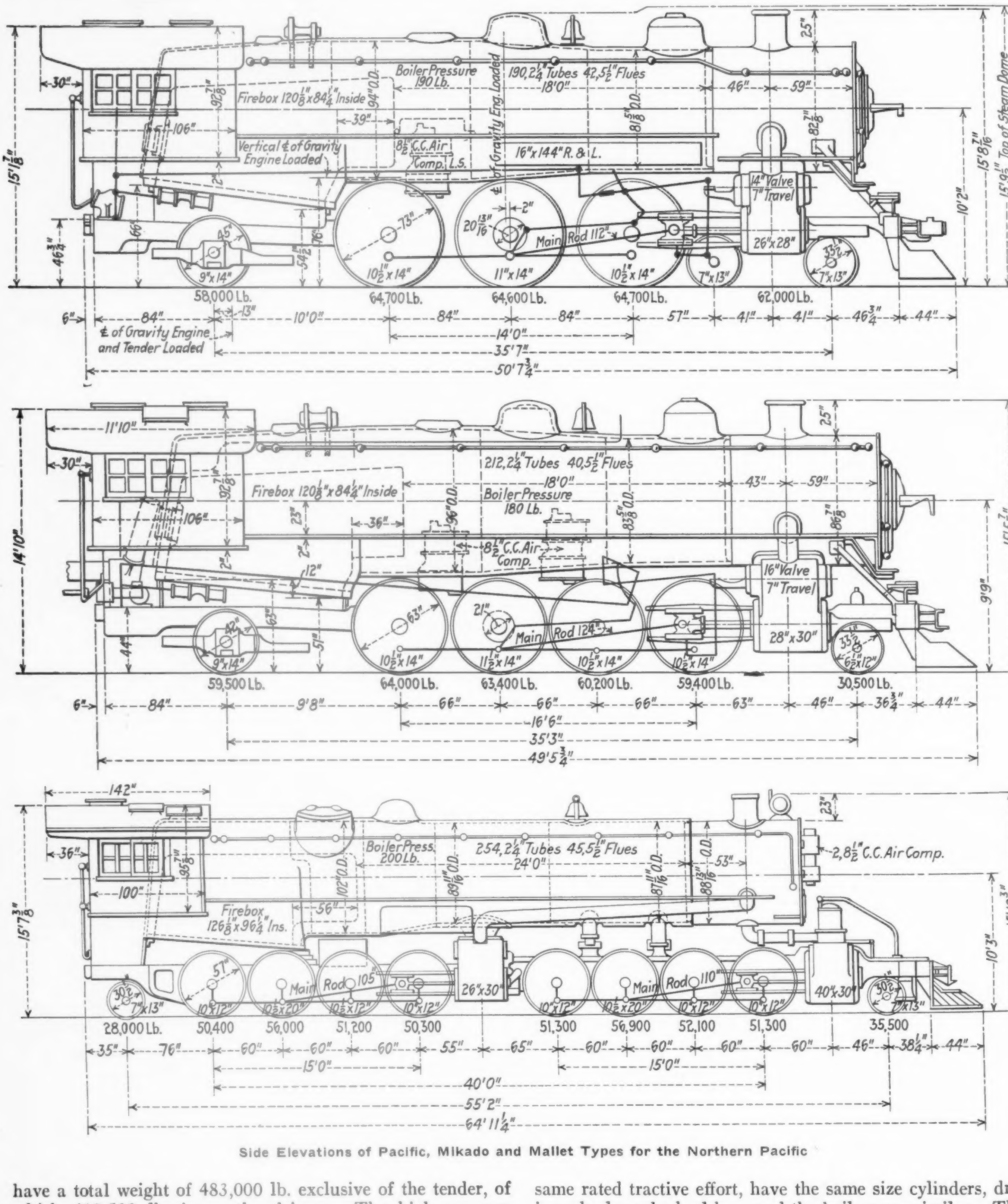
Mallet Type Locomotives Used Either as Road Engine or Helper

heavy. On the Seattle division they are used as road engines, handling 2,400 tons between Auburn and Lester, the grade being uniformly 1.0 per cent. Helpers are used from Lester to the summit of the Cascade Mountains.

These locomotives have a rated tractive effort of 105,100 lb. operated simple and 87,600 lb. operated compound. They in. by 96¼ in., with combustion chamber 56 in. long, tubes 24 ft. long, brick arches and superheaters.

Eight-Wheel Switchers

These locomotives are of a new design and resemble closely those ordered by the U. S. R. A. Both designs are of the



Side Elevations of Pacific, Mikado and Mallet Types for the Northern Pacific

have a total weight of 483,000 lb. exclusive of the tender, of which 419,500 lb. is on the drivers. The high pressure cylinders are 26 in. by 30 in., the low pressure cylinders 40 in. by 30 in., and the driving wheels are 57 in. in diameter. The boilers are of the conical connection type, firebox 126⅛

same rated tractive effort, have the same size cylinders, driving wheels and wheel base and the boilers are similar. They have 25 in. by 28 in. cylinders, 51 in. wheels, weigh 217,000 lb., a wheel base of 15 ft. and are designed to operate on 19 deg. curves.

Details and Specialties

Longitudinal boiler seams are welded for a length of 18 in. at front and back except the seams over the combustion chamber which are welded at the front end only on the Pacific and Mikado locomotives and are not welded on the Mallets. The top seam in the smoke box is also welded. The fireboxes of all types have the crown and side sheets made of a single piece. The combustion chamber is also made in one piece, butt welded on the bottom center line and butt welded to the firebox crown. Two 2 in. combustion tubes are used in each side of all fireboxes. Injectors are of the Hancock non-lifting type and feed water enters the boiler through vertical check valves. All boilers are equipped with Butterfly firedoors and brick arches. Duplex type D stokers are used on the Mikado and Mallet locomotives, and coal pushers on the tenders of the switcher and Pacific locomotives.

Driving axles are of hammered open-hearth steel, oil heat treated. Front truck, trailing truck and tender axles are of open-hearth carbon steel, oil heat treated, as are also the crank pins. On the Mallet engines the main crank pins are hollow bored. Bushings in cylinders and steam chests and also packing rings for main and valve pistons are of Hunt-Spiller iron. Extended piston rods are used on the Mikado locomotives and on the low pressure cylinders of the Mallets. Walschaert valve gear is used on all types. Ragonnet power reverse gear is applied to the switch engines, while the locomotives of the other types have Mellin reverse gears with oil pistons. Other specialties used are Pyle National electric head and back-up lights, Franklin grate shakers, pneumatic cylinder cocks and Chicago flange lubricators.

The important dimensions, weights and factors of the four types of locomotives are given in tabular form herewith.

BURNING COKE BREEZE WITH BITUMINOUS COAL.—Tests were recently conducted by the Bureau of Mines, Department of the Interior, to determine the steaming value of coke breeze as a fuel when mixed with coal and fired by hand, and to see whether the mixture would give off an objectionable quantity of smoke.

The tests carried out showed that mixtures of the coarser coke breeze, which passed through a one-inch screen, with Pittsburgh coal gave less than one-half the smoke given out by Pittsburgh coal alone, about 20 per cent less steam, and required a stronger draft to burn them. The steaming value of the coarser coke breeze is about 70 per cent of that for the Pittsburgh run-of-mine coal, and to allow for the possible necessity of using steam jets to give the required draft, its price to compete with Pittsburgh coal for steam generation should be less than 70 per cent of the price for Pittsburgh coal.

The finer coke breeze, which passed through a one-half inch screen, was shown to give steam at nearly as high an efficiency and with practically the same draft as the coarser breeze at a low rate of steaming. But the draft required to burn it rose very rapidly and the thermal efficiency fell considerably at a somewhat higher rating, so that the finer coke breeze can be recommended only for use at low rates of combustion, and when used at this rating it emits more smoke than the coarser mixture emits.

DIMENSIONS, WEIGHTS AND RATIOS OF NEW NORTHERN PACIFIC LOCOMOTIVES

	Switch 0-8-0	Pacific 4-6-2	Mikado 2-8-2	Mallet 2-8-8-0
Tractive effort, 85 per cent, m. e. p.	51,000 lb.	41,900 lb.	57,100 lb.	105,100 simple 87,600 compound
Speed at estimated maximum horsepower	....	46.5 m. p. h.	11.8 m. p. h.	10.6 m. p. h.
Cylinders, diameter and stroke	25 in. by 28 in.	26 in. by 28 in.	28 in. by 30 in.	H.P., 26 in. by 30 in. L. P., 40 in. by 30 in.
Valves, kind and size	Piston, 14 in.	Piston, 14 in.	Piston, 16 in.	H. P., piston, 14 in. L. P. slide
Greatest travel	6½ in.	7 in.	7 in.	H. P., 6 in. L. P., 6 in.
Lap	1 1/16 in.	1¼ in.	1 3/16 in.	H. P., 15/16 in. L. P., 15/16 in.
Exhaust clearance	0	¼ in.	0	H. P., ¼ in. L. P., 1/16 in.
Lead in full gear	1/16 in.	F, 1/16 in. B, 9/16 in.	⅛ in.	H. P., ¼ in. L. P., 3/16 in.
Weights in working order—				
On drivers	217,000 lb.	181,000 lb.	247,000 lb.	419,500 lb.
On front truck	....	69,000 lb.	30,500 lb.	35,500 lb.
On trailing truck	....	64,000 lb.	59,500 lb.	28,000 lb.
Total engine	217,000 lb.	314,000 lb.	337,000 lb.	483,000 lb.
Tender	163,000 lb.	198,600 lb.	214,000 lb.	213,000 lb.
Total engine and tender	380,000 lb.	512,600 lb.	551,000 lb.	696,000 lb.
Wheel base—				
Driving	15 ft. 0 in.	14 ft. 0 in.	16 ft. 6 in.	15 ft. 0 in., and 15 ft. 0 in.
Total engine	15 ft. 0 in.	35 ft. 7 in.	35 ft. 3 in.	55 ft. 2 in.
Total engine and tender	53 ft. ½ in.	71 ft. 3¼ in.	70 ft. 11¼ in.	83 ft. 6¼ in.
Wheels and journals—				
Driving wheels, diameter over tires	51 in.	73 in.	63 in.	57 in.
Driving journals, diameter and length—				
Main	10 in. by 12 in.	11 in. by 14 in.	11½ in. by 14 in.	10½ in. by 20 in.
Others	9 in. by 12 in	10½ in. by 14 in.	10½ in. by 14 in.	10 in. by 12 in.
Front, truck wheels	....	33½ in.	33½ in.	30½ in.
Trailing truck wheels	....	45 in.	42 in.	30½ in.
Tender wheels	33 in.	36 in.	36 in.	36 in.
Boiler, type	Straigth top	Conical Conn.	Conical Conn.	Conical Conn.
Steam pressure	175 lb.	190 lb.	180 lb.	200 lb.
Fuel	Bit. coal	Sub. Bit. Coal	Sub. Bit. Coal	Sub. Bit. Coal
Diameter, first ring, inside	78 5/16 in.	80 in.	82 in.	86 in.
Firebox, length and width	102 in. by 66¼ in.	120⅛ in. by 84¼ in.	120⅛ in. by 84¼ in.	126⅛ in. by 96¼ in.
Combustion chamber, length	....	39 in.	36 in.	56 in.
Arch tubes, number and diameter	3—3 in.	4—3½ in.	4—3½ in.	4—
Tubes, number and diameter	229—2 in.	190—2¼ in.	212—2¼ in.	254—2¼ in.
Flues, number and diameter	36—5½ in.	42—5½ in.	40—5½ in.	45—5½ in.
Tubes and flues, length	15 ft.	18 ft.	18 ft.	24 ft.
Heating surface, firebox	185 sq. ft.	300 sq. ft.	288 sq. ft.	332 sq. ft.
Heating surface, arch tubes	18 sq. ft.	35 sq. ft.	35 sq. ft.	41.6 sq. ft.
Heating surface, tubes	1,785 sq. ft.	2,002 sq. ft.	2,234 sq. ft.	3,575 sq. ft.
Heating surface, flues	772 sq. ft.	1,082 sq. ft.	1,030 sq. ft.	1,548 sq. ft.
Heating surface, total	2,760 sq. ft.	3,419 sq. ft.	3,587 sq. ft.	5,497 sq. ft.
Superheater surface	652 sq. ft.	928 sq. ft.	874 sq. ft.	1,305 sq. ft.
Equivalent heating surface	3,738 sq. ft.	4,811 sq. ft.	4,898 sq. ft.	7,454 sq. ft.
Grate area	47 sq. ft.	70.3 sq. ft.	70.3 sq. ft.	84.3 sq. ft.
Tender—				
Water capacity	8,000 gal.	10,000 gal.	10,000 gal	10,000 gal.
Fuel capacity	12 tons	14 tons	16 tons	16 tons
Ratios—				
Weight on drivers ÷ tractive effort	4.25	4.32	4.32	Simple 3.99 Compound 4.78
Tractive effort × diameter drivers ÷ equivalent heating surface	696	636	735	Simple 804 Compound 670
Equivalent heating surface ÷ grate area	79.5	68.4	69.7	88.4
Firebox heating surface ÷ equivalent heating surface, per cent	5.43	6.98	6.59	5.01
Total weight ÷ equivalent heating surface	58. 1	65.2	68.7	64.8

Preparation and Distribution of Fuel*

BY P. E. BAST

Fuel Engineer, Delaware & Hudson

THE railroads of this country use annually about 150,000,000 tons of coal. It was not at all improbable that five per cent more ash was included in railroad coal shipped during 1920 than in normal times. If this is true, 7,500,000 tons of additional ash was handled and hauled. But this tells only a part of the story. It has been authoritatively stated that there is a decrease of about 1½ per cent in efficiency for each additional one per cent ash content in the coal. The addition of the 5 per cent of ash means a reduction in efficiency of the good coal of about 7½ per cent, which together with the 5 per cent of ash makes a total reduction in efficiency 12½ per cent. Therefore, if five per cent more ash was included in the coal used by the railroads in 1920 than during normal times, it would be equivalent to 18,750,000 tons of coal with a money value of $75,000,000. Each one per cent reduction in extraneous ash would result in a saving of $15,000,000. To this must be added the waste in car mileage, the additional handling of ashes, delays to traffic, etc., the total of which is no inconsiderable amount. It would, therefore, appear that the preparation of railroad coal should command the careful attention of every railroad operating official.

It would seem reasonable that any railroad consuming an annual minimum of say 100,000 tons could well afford a mine inspection service, the expense of which would be negligible compared with the results possible to obtain.

Preparation of coal in the mine is the very foundation of fuel economy. The operator should feel his sense of responsibility in living up to the true intent of the railroad's contract or specifications, impressing upon his miners and other employees the necessity for clean coal, the railroads cooperating to the fullest extent through their mine inspectors.

The extraneous or free impurities in coal usually consist of slate, shale, mud seams, mother coal, sulphur balls or lenses, sand rock from the mine roof and clay from the mine floor. Sulphur, in the form of pyrites, shale, mother coal and thin slate partings are the most difficult to eliminate because they are more or less broken and intermingled with the coal when it is shot down, but with special care on the part of the miner during shooting and loading in the mine cars, these impurities can be thrown out and consigned to the dump pile. There should be no excuse for the loading of roof slate, sand rock, clay from the mine floor, thick slate bands, sulphur balls and lenses, inasmuch as any one of these last mentioned impurities can be detected in the mine and on railroad cars during loading.

Some coal seams have a distinct strata of bony coal. Precaution should be taken to eliminate this bony structure to a minimum. It could be used at mine power plants or disposed of locally.

Preparation of coal has so many varying angles that it would be difficult and unwise to set down any ironclad rules, yet it is believed that if the following few suggestions were carried out it would result in reducing the ash content of railroad fuel and would relieve the railroads of the burden and expense of transporting superfluous waste.

1. Periodical inspection of mine working places by proper mine authorities to see that coal is mined and prepared according to instructions.
2. Check system to determine the responsibility for loading dirty coal; discipline or docking, if law and agreements permit.
3. Shooting down coal so as to keep the percentage of slack down to a minimum.
4. Installation of picking tables where the nature of the coal requires extra precaution in preparation.
5. Proper and adequate drainage facilities.
6. Inspectors on railroad cars during loading to throw out removable impurities.

Consideration should be given co-operation of the railroad mine inspector and operator so that coals normally classified as undesirable can be made to meet the requirements of the railroads. This applies where coals least commercially salable are used by the coal bearing roads from a traffic development standpoint.

Expensive controversies and rejection of coal could be reduced to a minimum if the railroad would first obtain a complete inspection of the mines, showing all details of their methods of working, as well as of the coals offered before purchasing or making contracts.

Distribution

Distribution of coal is another important step in fuel economy. Like preparation, it is subject to many varying conditions such as irregularity of mine shipments, weather and traffic conditions, shortage of labor, power and car equipment, etc.

During the past three years distribution has been more or less demoralized due to motive power and car shortages, traffic congestion, labor disturbances, etc., and until these conditions have become stabilized for a comparatively reasonable period distribution will still continue to be subject to necessity.

It would be rather difficult to estimate or even approximate the annual loss to the railroads on account of poor distribution, such, for instance, as the placing of improper equipment under load at coaling platforms, stations, chutes and storage systems; overstocking, causing extra handling and per diem charges on foreign cars; the loss from a shortage of coal which necessitates holding back revenue tonnage in order to rush coal to some particular point, also in many cases, much to the displeasure of the shipper and inconvenience of the consumer, making it necessary for the railroad to confiscate commercial shipments in transit, which must be paid for at a relatively high price, and last but not least, cross-hauling.

There seems to be a difference of opinion among railway officers as to the department to handle the distribution. This is evident from a survey of thirty railroads covering practically every section of the country. The distribution by departments was as follows: transportation, 16; fuel, 9; mechanical, 2; purchasing, 2; by committees, composed of representatives of different departments, 1.

When we consider the variations in the different coals used by the railroads it can readily be seen how important it is that the coal distributor be familiar with the product that he is distributing. However, on many railroads this is not the case, and the lack of this knowledge has resulted in the slowing up of transportation by the distribution of coals to certain districts where the crews were not familiar with them or the power conditioned for their use.

Every railroad should have a distribution schedule based on the location of mines and characteristics of the coal so far as grade and quality are concerned. Since contract coal for any particular railroad using a large tonnage is bound to be of varying qualities, it would seem preferable to select the most desirable coal contracted for as a standard, the other coals then being compared and computed in terms of the standard. Distribution would then be simplified, so far as supplying to each district and class of service a uniform grade and quality of coal, which is a very important item from a standpoint of fuel conservation.

Distribution in a general sense is not a one department problem, it requires the closest co-operation of the several

*Abstracted from a paper presented before the 1921 convention of the International Railway Fuel Association.

departments and with this in view the following suggestions are made regarding the distribution of supply coal:

1. A consumption schedule for all points, frequently revised and kept up to date to meet the demands of traffic, etc.
2. A distribution schedule showing coals contracted for, grading of coals to a fixed standard, showing grades and qualities most suitable for each district and class of service.
3. A schedule showing coal consigned from mines to be shipped preferably to point of consumption with a view of eliminating extra handling and cross-haulage.
4. Daily telegraphic report showing coal on hand under load at each coaling station.
5. Daily telegraphic report covering shipments of coal and receipts at junction points, in order to keep the loads up to a reasonable degree of safety and down to a minimum with reference to transportation needs.
6. Storage of coal during summer months, relieving the road from transporting company coal in the winter months during the season of peak load. This has special reference to railroads located beyond a reasonable distance from coal fields.
7. From a purchasing standpoint, the most economical grade and quality of coal for each district with consideration to price, freight rates, mine locations, etc.

Discussion

Most of the discussion dealt with the problem of preparation of coal at the mine, C. F. Richardson (West Kentucky Coal Company) frankly discussed the usual relations between the railroad and the mine and stated emphatically that in order to get clean coal the railroads must be ready to pay a price that will make it possible for the operator to pay the men required on the picking table. He suggested that the railroad purchasing agent might well pay a premium for 100 per cent coal, rather than to buy 70 per cent coal and 30 per cent rock, on a price basis only. He also stated that the demand for tonnage by the railroad is not an incentive for the operator to clean his coal properly, since thoroughly cleaned coal reduces the tonnage output of the mine.

Eugene McAuliffe pointed out that while the B.t.u. basis of purchasing coal is probably the best available, it is not an accurate standard, because variations in ash produce a disproportionate effect on the heating value of the coal beyond the direct effect on the B.t.u. content.

The importance of having a coal distributor was pointed out by W. L. Robinson (B. & O.), in order to avoid the necessity for confiscating commercial coal for railroad use to meet the immediate requirements of some stations. Such coal frequently costs as high as $16 a ton.

Important Factors in Design of Locomotive Boilers

Boilers Should Be Proportioned on Cylinder Horsepower and Air and Gas Areas Considered

BY J. T. ANTHONY
Vice-President, American Arch Company

This article is a continuation of the discussion in regard to the factors which should be considered in comparing the design of various locomotives. In this connection attention is called to an article in the Railway Mechanical Engineer of April, 1921, *page* 211, *by Lawford H. Fry, on the Comparison of Locomotive Dimensions and to articles by E. C. Poultney on the Dimensions and Proportions of British Locomotives in the Railway Mechanical Engineer for September and October,* 1921.—EDITOR.

IN my opinion too much stress is laid on the mere subject of heating surface and too little attention is paid to the location and distribution of the heating surfaces. Some of the most important factors in design are the ratio of the tube length to the inside diameter; the ratio of the firebox heating surface to the total heating surface; the ratio of the superheating surface to the total heating surface; and particularly the relation between the net gas area through the tubes and the power to be developed.

In Table 1 are shown some of the most important data on four designs of Mikado (2-8-2 type) locomotives, together with the ratios, which, to my mind, are important. The last two—the ratio of the air inlet through the ash pan and through the grates to the grate area—are never shown and are probably considered a matter of no importance; but I am satisfied that the lack of attention paid to these ratios is costing our railroads a lot of money.

In designing the locomotive boiler the method usually followed is to determine the cylinder horsepower output at a piston speed of 1,000 ft. per min. for superheated locomo-

TABLE 1
DIMENSIONS AND FACTORS OF TYPICAL MIKADO LOCOMOTIVES

Road	G. T.	I. C.	S. A. L.	Penn.
Tractive effort	51,600 lb.	51,700 lb.	50,200 lb.	57,850 lb.
Cylinders, diameter and stroke	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.
Weight on drivers	204,700 lb.	218,300 lb.	208,000 lb.	235,800 lb.
Total weight of engine	272,100 lb.	282,700 lb.	282,000 lb.	315,000 lb.
Cylinder horsepower	2,296	2,296	2,230	2,690
Boiler pressure	175 lb.	175 lb.	170 lb.	205 lb.
Boiler type	W. T.	Straight	Ext. W. T.	Belpaire
Boiler, outside diameter, front end	74 in.	82 in.	74 in.	80½ in.
Tubes, number and diameter	240–2-in.	262–2 in.	230–2 in.	237–2¼ in.
Flues, number and diameter	32–5⅜ in.	36–5⅜ in.	32–5⅜ in.	40–5½ in.
Tubes and flues, length	20 ft. 0 in.	20 ft. 6 in.	20 ft. 0 in.	19 ft. 0 in.
Heating surface, firebox	249.8 sq. ft.	272.2 sq. ft.	247 sq. ft.	302 sq. ft.
Heating surface, tubes and flues	3,400 sq. ft.	3,834 sq. ft.	3,295 sq. ft.	3,716 sq. ft.
Heating surface, superheater	769 sq. ft.	887 sq. ft.	760 sq. ft.	1,172 sq. ft.
Heating surface, total (including superheater)	4,418.8 sq. ft.	4,993.2 sq. ft.	4,302 sq. ft.	5,190 sq. ft.
Net gas area through tubes and flues	6.39 sq. ft.	7.06 sq. ft.	6.23 sq. ft.	8.44 sq. ft.
Grate area	56.5 sq. ft.	70.4 sq. ft.	63.2 sq. ft.	70.0 sq. ft.
Firebox volume	....	....	....	427 cu. ft.
Air inlets through ashpan	....	....	....	8.44 sq. ft.
Air inlets through grates	....	....	....	19.43 sq. ft.
Weight on drivers ÷ total weight	0.752	0.772	0.737	0.749
Weight on drivers ÷ tractive effort	3.97	4.22	4.14	4.11
Total weight ÷ tractive effort	5.27	5.47	5.62	5.45
Total weight ÷ cylinder horsepower	119	123	127	117
Cylinder horsepower ÷ grate area	40.6	32.6	35.3	38.4
Cylinder horsepower ÷ gas area	359	325	358	319
Tube length ÷ inside diameter of tube	137	140	137	114
Total heating surface ÷ cylinder horsepower	1.92	2.17	1.93	1.93
Superheater surface ÷ total heating surface	17.4	17.7	17.6	22.58
Firebox heating surface ÷ total heating surface	5.65	5.45	5.74	5.81
Firebox volume ÷ grate area	....	....	....	6.10
Air inlet through grate ÷ grate area	....	....	....	28.8
Air inlet through ash pan ÷ grate area	....	....	....	11.1

tives, and from this figure determine the grate area on the supposition that one horsepower hour requires $3\frac{1}{4}$ lb. of coal, the maximum allowable rate of combustion being 120 lb. of coal per square foot of grate per hour. The total steam required per hour is obtained by multiplying the cylinder horsepower by 20.8 for superheated locomotives, and the amount of heating surface required to give this evaporation is based on the Coatesville test which showed 55 lb. evaporation per square foot of firebox heating surface, and about 10 lb. for tube heating surface.

I am satisfied that these evaporation figures can be, and often are, greatly exceeded in locomotive practice, and that the main problem is to design a firebox that will liberate the heat; then provide sufficient gas area to enable the firebox to free itself of the gases of combustion, without unduly high drafts; and last, to determine the correct proportion between the diameter and length of the tubes. A logical method for the design of locomotive boiler would be about as follows:

Cylinder horsepower, according to the American Locomotive Company method = .0229 x P x A where

P is equal to boiler pressure and

A is equal to the area of one cylinder in square inches.

$$\text{Grate Area} = \frac{\text{Cyl. h.p. x 3.2}}{120} \text{ for Coal of 14,000 B.t.u.}$$

If coal of inferior quality is to be burned it is necessary to burn more of it in order to get the same heat output, and if the poorer coal is to be burned with the same degree of efficiency it is necessary to keep the rate of combustion down to 120 lb., which requires a larger grate. Therefore the grate area should be equal to $\dfrac{\text{Cyl. h.p. x .37}}{\text{1000 B.t.u. in coal}}$

With poor Western coal running 11,000 B.t.u., this gives a rather large grate area, but as most heavy engines are now being stoker-fired there is no logical reason why the larger grates should not be used. Of course, the argument against the larger grate is that it increases the standby losses. If a locomotive is designed to adorn the terminal tracks and sidings the argument is effective; but if it is designed to haul heavy trains at fair speeds and at the same time to burn a poor quality of coal efficiently, the larger grate will prove more economical than the smaller one, regardless of the standby losses.

Having determined the grate area the question of net gas area through the flues should next be considered.

According to the best information available when firing a high grade Pennsylvania coal at the rate of combustion of 120 lb. of coal, there is formed about 10.35 lb. of gas for each pound of coal fired, which equalled, in the particular locomotive, 9,660 lb. of gas per hour per square foot of flue opening. At higher rates of combustion there is a decrease in weight of gas per pound of coal, and but a slight increase in the total weight of gas formed. Thus at the rate of 170 lb. of coal per square foot of grate per hour only 10,800 lb. of gas pass through each square foot of tube and flue opening. It is possible that even a greater weight of gas could be put through each square foot of opening without unduly increasing the draft; but I have no accurate data as to this. Using 10,800 lb. as a base figure, however, the net gas area required is $\dfrac{\text{Cyl. hp. x 3.2 x 10.35}}{10{,}800} = \dfrac{\text{Cyl. hp.}}{330}$

Having determined the gas area required this would be apportioned between the superheater and the smaller tubes as follows, using 40 per cent of the area for superheater flues:

$$\text{No. Units } 5\tfrac{1}{2} \text{ in. Flues} = \frac{\text{Gas area in sq. in. x 0.4}}{11.78}$$

$$\text{No. Units } 5\tfrac{3}{8} \text{ in. Flues} = \frac{\text{Gas area in sq. in. x 0.4}}{10.78}$$

The remaining 60 per cent of gas area goes to be used for the 2 in. or $2\frac{1}{4}$ in. tubes.

$$\text{No. Tubes} = \frac{\text{Remaining gas area in sq. in.}}{\text{Area of one 2 in. or } 2\frac{1}{4} \text{ in. tube}}$$

The length of the tubes should not be in excess of 120 times the inside diameter. While, personally, I think that 110 is a better ratio, I have used the larger figure to be conservative. A 2-in. tube with $1\frac{3}{4}$ in. inside diameter would, therefore, be 17 ft. 6 in. long, and a $2\frac{1}{4}$ in. tube with 2 in. inside diameter would be 20 ft. long. The use of the shorter tubes in long wheel base engines of the Mikado, Pacific and Santa Fe types would, of course, necessitate longer combustion chambers, and this, to my mind, is an advantage. I would make the combustion chamber as long as necessary to connect the tubes with the firebox.

In Table 2 are shown the same locomotives as in Table 1, with the boilers figured according to the method above outlined and some of the resulting ratios. Different grades of fuel have been used for the four roads in order to illustrate their effect on the grate area. The ratios between the grate area and heating surface have not been shown, as with the above method of boiler design differences in such ratios would only indicate a difference in the B.t.u. content of the fuel.

It will be noted that no mention has been made of cylinder volume, nor have any ratios been shown containing this item, as it is of no importance and should be replaced by the cylinder horsepower.

The ratio of firebox volume to grate area should be at least six and as much greater as is possible to obtain.

I have not made any calculations as to the increase or decrease in weight of boilers which would be brought about by the suggested methods of designing, but this should differ but little from the results when following present practice.

TABLE 2

LOCOMOTIVES AS REDESIGNED BY SUGGESTED RATIOS

Road	G. T.	I. C.	S. A. L.	Penn.
Tractive effort	51,600 lb.	51,700 lb.	50,200 lb.	57,850 lb.
Cylinders, diameter and stroke	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.
Boiler pressure	175 lb.	175 lb.	170 lb.	205 lb.
Cylinder horsepower	2,296	2,296	2,230	2,690
B. t. u. per lb. of fuel used	12,500	12,000	13,500	14,250
Grate area	68 sq. ft.	70.8 sq. ft.	61.1 sq. ft.	70 sq. ft.
Net gas area, sq. ft. = cylinder horsepower ÷ 330	6.96	6.96	6.76	8.15
Tubes, number and diameter	256–2 in.	256–2 in.	246–2 in.	290–2-in.
Flues, number and diameter	36–$5\frac{3}{8}$ in.	36–$5\frac{3}{8}$ in.	36–$5\frac{3}{8}$ in.	44–$5\frac{3}{8}$ in.
Tubes and flues, length	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.
Firebox heating surface, approx	290 sq. ft.	320 sq. ft.	287 sq. ft	330 sq. ft.
Tube and flue heating surface, approx	3,230 sq. ft.	3,230 sq. ft.	3,140 sq. ft.	3,740 sq. ft.
Superheating surface, approx	720 sq. ft.	720 sq. ft.	720 sq. ft.	1,188 sq. ft.
Heating surface, total (including superheater)	4,240 sq. ft.	4,270 sq. ft.	4,147 sq. ft.	5,258 sq. ft.
Firebox volume	*50 cu. ft.	*60 cu. ft.	*50 cu. ft.	457 cu. ft.
Total heating surface ÷ cylinder horsepower	1.85	1.86	1.86	1.95
Superheater surface ÷ total heating surface	17.00	17.00	17.3	22.6
Firebox heating surface ÷ total heating surface	6.84	7.49	6.92	6.27

*The firebox volumes under the first three locomotives could not be shown, due to lack of data: but shortening the tubes to 17 ft. 6 in. length increases the present firebox volume by the amount shown.

European View of Steel vs. Copper Fire-Boxes*

Extensive Tests on the Orleans Railroad Demonstrate Superiority of Steel Fireboxes

BY PAUL CONTÉ

IT can be said, in a general way, that the fire-boxes of the boilers of locomotives are made of steel in the United States, whereas almost everywhere else they are made of copper, particularly in Europe. It cannot be given as a reason for the greater use of copper that this metal is a better conductor of heat. The trials made by the Pennsylvania Railroad, at Altoona, with locomotives equipped with steel fire-boxes showed that the heating surface gave forth as much heat in the case of these fire-boxes as with the fire-boxes of the boilers made of copper, and it is, moreover, a well known fact that the power of the boilers was not diminished when copper tubes were replaced by steel. As far as the ease of making repairs is concerned, this is about the same with the steel as with the copper fire-boxes, and it can even be said that, since the practical use of autogenous welding, repairing is easier with the steel than with the copper fire-boxes.

In Europe extensive trials at replacing copper fire-boxes

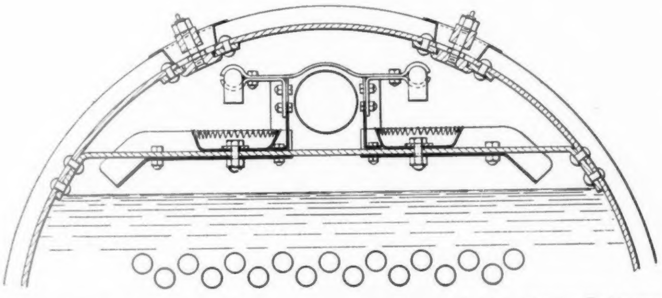


Fig. 1—"Trick Feeds" Used on Locomotives of the Paris-Orleans

with steel have failed because the steel fire-boxes suddenly cracked either in the middle of the plates or else fissures appeared radiating from the rivet holes, and these accidents appeared to be the result of the rapid cooling of the plates. We were, therefore, led to conclude that, in order to maintain the steel fire-boxes in good condition, it was necessary to avoid submitting them to any rapid change in temperatures, and the reason the Americans were able to continue to use steel fire-boxes was because of the special precautions which they must have taken to avoid these rapid changes and which we in Europe knew nothing about. During a trip for study to the United States, we were able to examine these precautions closely, and we found that they could be summed up in two definite rules:

1. The boiler should never be washed except with hot water and it should also never be filled except with hot water.
2. The formation of scale on the lining of the fire-box should be avoided as much as possible.

The washing and the filling with hot water is now performed in the large American terminals by using fixed pipes fed by special boilers. In terminals of lesser importance, the injector of an engine under steam is used. It was therefore necessary before renewing the trials of the steel fire-box on the Orleans railroad, to begin by spreading the practice of washing and filling the boilers with hot water, either by employing the injector of a locomotive under steam, or by some other means. It was only when this custom had been generally adopted on the railroad that we were able to again take up the trials of the steel fire-boxes.

These trials began in 1907. In order to carry them out under the best conditions, the 12 fire-boxes put into service from 1907 to 1908 were ordered in the United States and delivered completely erected. The staybolts were also made from charcoal iron bars from the United States. Furthermore, in order to avoid as far as possible the formation of scale on the lining of the fire-box, it was decided to use in connection with the trial boilers a special system of steam feeding which allows the water employed for filling to be heated by the steam of the boiler to a temperature near that of the saturated steam.

"Trick Feeds" on the Orleans Railroad

This very simple system, called on the Orleans railroad "Trick Feeds," is composed merely of a tray placed inside the body of the boiler shell above the normal level of the water, and on which the water for filling the boiler falls. (See Fig. 1.) The water spreads out in a thin layer on the tray before running into the boiler, is heated by the contact with the steam and the scale falls off in small particles which drop on the tray or run along the walls of the barrel to its bottom. The crystallizing of the scale on the walls of the boiler and particularly on those of the fire-box is thus avoided. It is naturally necessary to place a handhole outside the cylinder and above the tray in order to allow the complete cleaning of the tray.

These "Trick Feeds" have been placed on all the locomotives of the Orleans railroad constructed since 1906 with copper or steel fire-boxes and have never been the cause of any trouble. The boilers show a minimum amount of scale. Furthermore, by heating the supply water to the temperature of the water of the boiler, an equal temperature is obtained at all points of the boiler and in this way the formation of colder zones is avoided in the bottom of the barrel and in the water legs. We also noticed that with the engines equipped with "Trick Feeds" the lapse of time between heavy boiler repairs, such as the replacing of the tube sheet or the fire-box, was noticeably longer than with the locomotives of the series constructed before that time and which were not so equipped; but as different types of locomotives were concerned we were unable to draw definite conclusions.

Story of the Tests

The first use of steel fire-boxes was made in 1907 and 1908 on 12 locomotives, six of which were of the 2-4-6 type with a grate surface of 18.4 sq. ft. and six of the 0-8-0 type with a grate surface of 18 sq. ft. As this trial gave good results, it was continued and in 1909 and 1910 steel fire-boxes were placed on 27 boilers, 16 on 2-4-2 type locomotives and 11 on 0-8-0 type locomotives of the same sort as previously. In 1914, 40 more were added. In 1915, it was decided to replace with composite fire-boxes (rear plate only of copper) the copper fire-boxes of the old locomotives which had reached the limit of their service. Finally in 1918 and 1919 the Orleans railroad put into service 150 Mikado locomotives constructed in the United States with fire-boxes entirely of steel. At the end of 1917 the Orleans railroad had in service nine tube plates or composite fire-boxes on the

*Abstract of an article appearing in the Revue Generale des Chemins de Fer. Mr. Conté is a naval constructing engineer and also assistant chief engineer of the Central Office for the Study of French Railway Equipment.

four-cylinder compound engines and 160 fire-boxes of steel or composite on the old locomotives.

Results of the Trials

As regards heat transmission it was found that there was no difference between similar locomotives, whether the fire-boxes were of steel or of copper. From the point of view of upkeep, the trials showed a noticeable advantage in favor of the steel fire-boxes. In general the steel fire-boxes gave very good results. The locomotives of the 2-4-2 and 0-8-0 types had the door frames and the frames of the openings of solid forged iron which were retained. The result of this was that the part of the rear plate in contact with the frames was not heated by the water of the boiler. With the copper plate this arrangement does not give much trouble. The edge of the plate burns gradually, but only cracks after a long while, and a piece can be added to the rear plate around the frames of the door after a certain number of years. It is not the same when the rear plate is made of steel. At the end of a few years we noticed, as in the case of the Paris, Lyons, Mediterranean trials in 1893, that cracks showed themselves in the part of the plate in contact with the frame. These tests extending over a period of 11 years showed that in cases where solid frames were used for the door openings, it was preferable to make the rear plate of copper, and since 1914 all the steel fire-boxes installed in our locomotives under these conditions were composite fire-boxes. We have not, however, abandoned the idea of constructing complete fire-boxes of steel, and in the new spare boilers for locomotives of the 0-6-0 type put into service in 1918, as well as in the 150 Mikado engines in 1917, we constructed the fire-box entirely of steel, taking the precaution, however, to protect the part of the plate in contact with the door by a flame-shield and abolishing the small openings of this door. As the boilers were new, we took advantage of this fact to adopt a type of door opening in towards the fire-box which made it easier to install a proper flame-shield as mentioned above.

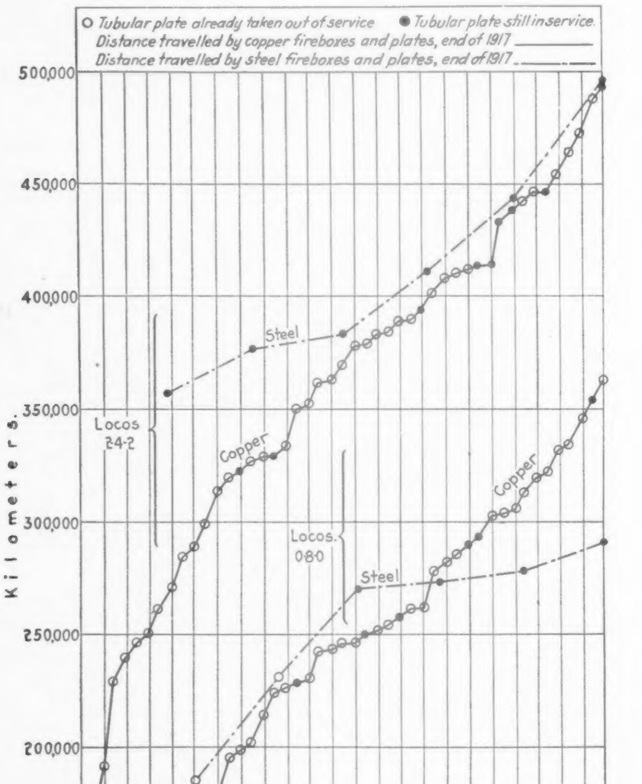


Fig. 2—Results of Tests of 1907-1908

As regards the 40 composite fire-boxes installed in 1914, at the end of 1918, we found trouble only in the case of three fire-boxes of locomotives of the 0-8-0 type resulting from

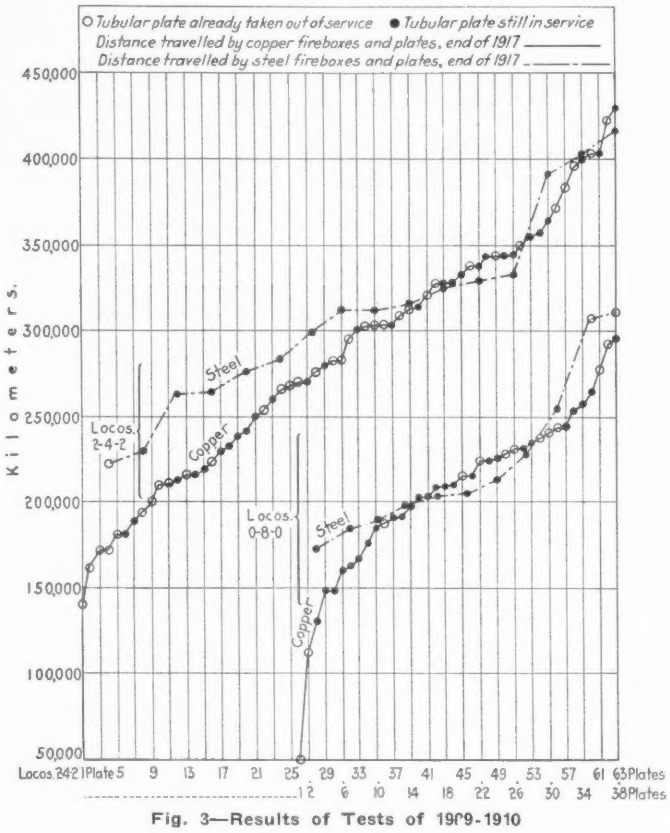


Fig. 3—Results of Tests of 1909-1910

circumstances which are worth while relating in order to show the ease with which steel fire-boxes are affected by cold. In these three locomotives from the Tessonnieres Terminal, with composite fire-boxes, cracks were found at the same time in 1916, in their sides, and in one of them in the tube plate, opposite the handholes for the washing of the outside envelope. An examination was made and it was found that, in order to easily do the washing, it was necessary to move the engines out of the terminal, and that the prevailing wind, which is very strong in that region, came from such a direction when the locomotive was at the wash-stand that it blew directly through the holes for washing and struck the plate opposite as soon as the cover was detached. As these cracks only occurred on one side of the engine, and always the same, it was proved that it was certainly the action of the wind which caused the cracks.

Lasting Qualities of Steel and Copper Fire-Boxes

The criterion for judging the wearing qualities of a fire-box is the distance traveled by the locomotive between the time the fire-box is installed and when it is replaced. As this distance is very great, both for the copper and for the steel fire-boxes, we have had to limit ourselves to comparing the distance traveled between the time of putting into service and the replacing of the tube plate, this plate being usually the first part which has to be replaced in a fire-box.

Six steel fire-boxes were installed in 1907 and 1908 on passenger engines of the 2-4-2 type. Up to the present time

no tube plate has been replaced. The average distance traveled by the six engines was 257,375 miles at the end of 1917. During the same period, 1907 and 1908, 46 copper fire-boxes or tubular plates were installed on the other locomotives of the same series. Out of the 46 plates, 38 had been replaced and the average distance traveled by these 46 engines, at the end of 1917, with the fire-boxes or tube plates installed in 1907 and 1908, was 225,000 miles. Out of the six steel fire-boxes placed on the locomotives of the 0-8-0 type, two tube plates were replaced after traveling an average distance of 130,000 miles. The average distance traveled by the six fire-boxes was 159,375 miles at the end of 1917. During the same period, 1907 and 1908, 43 copper fire-boxes or tube plates had been installed on locomotives of the same series. Thirty-seven have been replaced at the present time and the average distance traveled by these 43 fire-boxes or plates was 153,750 miles at the end of 1917.

The curves (Fig. 2), which show the distance traveled at the end of 1917 by all the plates, furnish an idea of the service given by the copper and by the steel plates.

Sixteen steel fire-boxes were installed in 1909 and 1910 on engines of the 2-4-2 type. Up to the present time only one tube plate had been replaced after traveling 138,750 miles. The average distance for these 16 fire-boxes was 194,375 miles at the end of 1917. During this same period —1909 and 1910—63 copper plates or fire-boxes had been placed on locomotives of the same series. At the present time 34 plates have been replaced and the average distance travelled at the end of 1917, by the 63 plates or fire-boxes was 179,375 miles.

Eleven steel fire-boxes were replaced during the same period on locomotives of the 0-8-0 type. Two fire-boxes were replaced after making an average of 194,375 miles. The average mileage made by the 11 fire-boxes was 136,250 miles at the end of 1917. During this same period, 1909 to 1910, 38 copper plates or fire-boxes were installed on engines of the same series. Fourteen tube plates have already been replaced and the average distance of the 38 tube plates or fire-boxes at the end of 1917 was 129,375 miles.

The curves in Fig. 3 show the comparative mileage made by the copper and the steel plates.

Effect of Scale on Steel and Copper Fire-Boxes

Contrary to what might have been expected at first thought, we noticed no particular effect on the steel fire-boxes caused by the nature of the water. We found no corrosion in the case of the fire-boxes filled with water of a nature likely to corrode the tubes. Furthermore, in the case of the steel or composite fire-boxes in service in the terminals of the railroad, particularly at Etampes and Capdenac where the water is very calcareous and contains a large percentage of calcareous salts, we noticed no formation of scale and no difficulty arose while in service, whereas the copper fire-boxes, fed with the same water, showed abnormal wear and cracks between the holes of the tubular plates. We must add that, during the war, a certain number of engines of the 0-8-0 type were used in the field service, particularly on the Nord railroad where the water is very calcareous. In spite of the special conditions under which these locomotives were used, no trouble with the fire-boxes has been brought to our attention.

It should be stated in connection with these tests that the steel fire-boxes were installed under the same conditions as the copper ones, without taking any special precautions. The rods were rivetted at the two ends and given a head slightly reduced in size, without receiving the usual finish of the copper rods. The assembling of the tubes in the tube plates was done by the American method: that is to say, by inserting a thin plate of copper between the tube and the plate and then expanding the tubes driving them into the plate and turning down the edges.

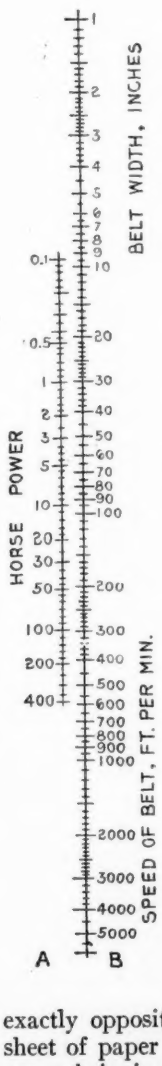
This method gave the best of results, and when the work is well done it is unnecessary to touch it again.

Conclusions

As a result of the very thorough trials which we have just described, we are convinced that by using the special precautions, which we have mentioned in this article, steel or composite fire-boxes can be substituted for copper ones. It would even seem that the length of service of steel fire-boxes were greater than that of the copper ones. Moreover, as the steel fire-boxes are much lighter and cheaper than those of copper, this conclusion is of the greatest importance. We draw attention again, however, to the absolute necessity, before making a trial or installing a large number of steel or composite fire-boxes on a railroad, of beginning by making it a general custom to do the washing and the filling of the boilers with hot water, in order that this may be the general practice, before putting the steel fire-boxes into service. A locomotive, as a matter of fact, has to go to several terminals of the railroad. The washing and filling with hot water should therefore be a general custom at all points. Otherwise one would run the risk of putting the fire-box out of service by one single washing with cold water done under bad conditions.

Chart Gives Power of Belts

BY W. F. SCHAPHORST



The accompanying chart will be found handy by belt men, or purchasers of belts, for figuring the belt width necessary to transmit any given power knowing the horsepower that is to be transmitted and knowing the speed of the belt. Likewise if the belt width and speed are known the horsepower can be determined, or if the belt width and horsepower are known, the speed at which the belt should be run is easily found.

For example, it is desired to transmit 10 hp. through a single leather belt, the belt speed to be 3,000 ft. per min. With a sheet of paper find the distance from the 10 in column *A* of the chart illustrated to the 3,000 in column *B*. Then step off the same distance upward from the 10 in column *A* to a point in column *B* and find the answer—3 in. wide.

Again if we have a belt 4 in. wide and wish to transmit 20 hp. with it, what must be the speed of the belt? With the same sheet of paper measure the distance from the 4, column *B*, to the 20, column *A*. Then from the 20, column *A*, measure downward the same distance to a point in column *B* and there is the answer—4,000 ft. per min.

Suppose that a 9-in. single belt is running at 2,000 ft. per min. What horsepower will it transmit? Find the midpoint between the 9, column *B*, and the 2,000, column *B*. Directly opposite the mid-point in column *A* is the answer—22.5 hp. An easy way in which to find the exact mid-point is to lay a sheet of paper along column *B*, the upper corner being exactly opposite the 9-in. column *B*. Make a mark on the sheet of paper opposite the 2,000, column *B*. Then fold the paper bringing the upper edge down to the mark and make a crease in the paper at the mid-point.

Turntable Indicating Device

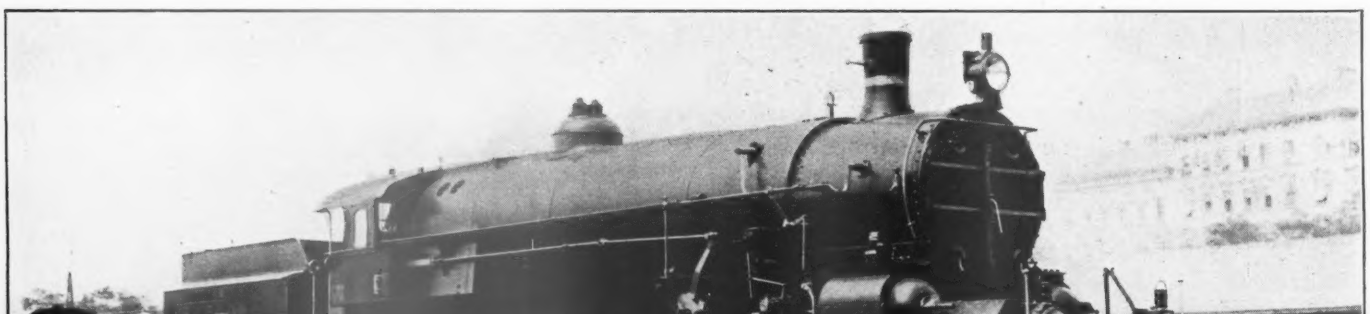
BY M. A. BOUYSOV

Considerable time is often lost at terminals in shifting a locomotive back and forth on a turntable until the table is in balance and can be readily revolved without unnecessary waste of power. Moreover, it is usually necessary to have a second man on the ground to signal the hostler when the locomotive has been placed correctly. To obviate these difficulties the turntable indicating signal, illustrated in Fig. 1, was applied in April, 1921, having been in service up to date with good results. The device was installed after an accident due to failure of the electric generator when it was necessary to operate this table with laborers. During this time it was noticed that with the table properly balanced it could be handled by two men and when not perfectly balanced it required from six to eight men to move it.

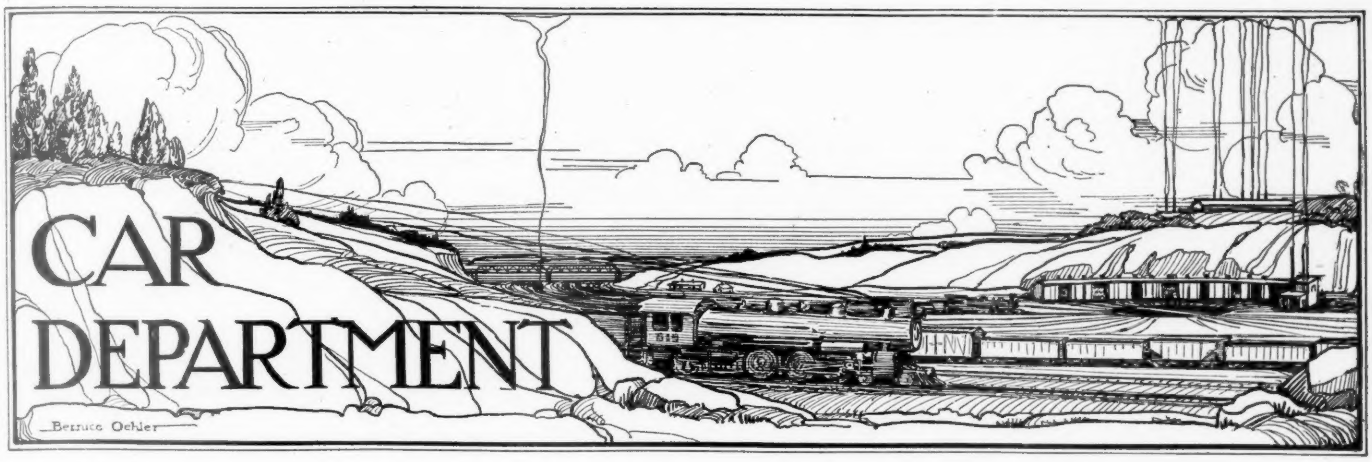
Fig. 1—View Showing Indicator Applied at Each End of the Turntable

With the indicator illustrated, it is now possible to tell when the table is balanced without the common practice of having an additional man at the end of the table to signal the hostler. Referring to Fig. 1 it will be evident that one signal is placed at either end of the turntable so as to be visible to the hostler no matter which way the locomotive is turned. The signal itself is a three-position signal, with bull's eye and semaphore blade. With the table balanced, both blades will stand in a horizontal position and when the table is unbalanced the flag at the high end will be tipped up, that at the other end being tipped down. The construction and operation of the turntable indicator will be evident from a close inspection of Fig. 2. The signal is operated by means of a vertical rod connected at its lower end to a hinged arm with a wheel traveling on the track. When a locomotive comes on one end of the turntable, that end goes down, but the wheel remaining at the same elevation on the track forms a fulcrum by which the vertical arm is pushed up, causing the blade to take a position below the horizontal. The relative proportions of wheel diameter and arm length are such as to bring the semaphore blade horizontal when the turntable is in a balanced position. With the construction described above it is evident that the indicator shows accurately whether the turntable is balanced or not, and if unbalanced, which way the locomotive will have to be moved to correct this condition and facilitate turning the table.

Fig. 2—The Construction of the Indicator Is Evident from This View



An Austrian Compound, Superheated Passenger Locomotive



Container Cars in Use in Poland

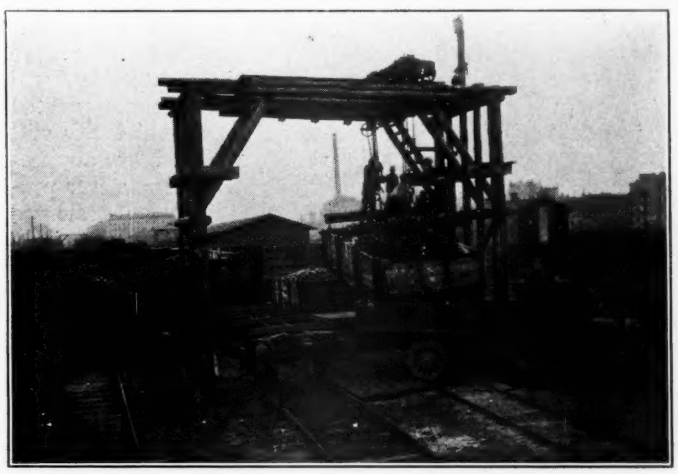
An interesting modification of the container type of car, designed for all classes of freight service, has recently been built by S. Rodowicz of Warsaw, Poland. The new construction is similar in principle to the cars that have been used to a limited extent in this country, though of more general application. The design provides an underframe equipped with trucks which can be utilized for hauling any type of superstructure, as open-top box, closed box, platform, tank, etc. The superstructures are interchangeable on the underframes and being removable can be transported without unloading and reloading from origin to destination, whether the shipment moves over standard or narrow gage railroads, by truck or by boat.

The construction of the cars is plainly shown in the drawings and photographs. The underframe is built integral with two two-wheel trucks and has a substantial center sill and end sill fitted with couplings and buffers. Extending across the underframe are crossbearers, to the upper side of

Container Car with One Body Removed Showing Details of Underframe

which are fitted pressed steel members of trapezoidal cross-section. The transverse beams in the bottoms of the bodies are spaced so as to fit accurately over the crossbearers, preventing longitudinal or lateral movement between the body and the underframe. One of the photographs shows the underframe fitted with two bodies, one of which has been removed. The second photograph illustrates the manner in which a dump body can be removed from the car and unloaded directly into a motor truck.

It is believed by using this type of car the investment in equipment can be reduced materially as a single underframe is sufficient for three complete superstructures. While one body is in transit on the underframe one will be loading and another unloading. By decreasing the number of units it is possible to make each unit of the most approved construction, provided with continuous brakes, without increasing the



Dumping the Load from a Container Car Onto a Motor Truck

investment required to handle a given tonnage. This in turn will make it possible to increase the speed of freight trains and thereby improve the performance of the individual cars.

Henry Ford Comments on Car Design

In an interview published in a recent issue of The Nation's Business, Henry Ford stated some of the methods whereby he intended to improve the operation of the railroads. As his criticisms of car design are of special interest, that section of the interview is given in full below.

"The second step would be to remove the great physical burden of the railroads—needless weight of rolling stock. Overweight of rolling stock is the prime mistake on the mechanical side of railroading. Engines and cars are four or five times as heavy as they should be. A freight train is several times the weight of the load it carries, and a passenger train is 20 times as heavy. This dead weight must be moved whether a train is loaded or empty. The cost of pulling empty trains is needlessly large. Contrast this with the efficiency of the bicycle which weighs 20 lb. and will carry a man who weighs 200 lb."

"It is contended," the interviewer suggested, "that weight is necessary to make railroad cars hold the track."

"Were you ever arrested for speeding?" Mr. Ford countered. "If so, the cop who overhauled you was mounted on a motorcycle that weighed about one-tenth as much as your car, yet it was speedier than you were. The problems of holding the rails can be taken care of in redesign.

"Here is an example of redesign in freight cars. The axle of a car and the two wheels upon it operate as a unit almost as though they were one piece. When the car goes around a curve one wheel has to travel farther than the other. Since they are on the same axle and one cannot turn without the other, this makes it necessary that one wheel should slip on the rail. There are theoretical compensations which it is claimed take care of this difference of distance traveled by wheels, but they are not real compensations. The axle connecting these wheels must be very strong to force the slip. To secure this strength the axle must be very thick and heavy.

"What we have set out to do is to design an axle that will allow for this difference in the distance the wheels have to travel, that will make the slip unnecessary. We have already solved the problem. But in doing so we have greatly reduced the weight of the undergear of every car.

"We are not governed in our redesign of rolling stock by what has gone before. We are going to make some revolutionary changes. We find that the present types of rolling stock can be greatly improved. On the Detroit, Toledo & Ironton we are using up the old types of engine and car, but they will be displaced by better types. We will patent our new designs where they are patentable, but we will do this only to prevent someone else from doing so. Some patents are taken out to prevent the free use of ideas. Our patents will guarantee the free use of ideas. We will never proceed against anybody for infringement of our patents. They will belong to the world. Anybody who wants to can use any improvement we make. The Ford organization has never proceeded against anybody for infringements of its patents.

"Great weight in trains, of course, calls for correspondingly heavy rails and ties. The producers of iron and steel have had much to do with the development of railroads. The heavier the engine and the heavier the rail, the greater was the consumption of steel and the greater profit all along the line. The builders of rolling stock have regarded, or have pretended to regard, size as an evidence of advancement. They have long ago passed the point of economy."

"It is said, Mr. Ford," I interjected, "that your claim of the economy of lighter rolling stock is an undemonstrated theory. How do you know that it would be more economical?"

"Well," he replied, "it doesn't do much good to talk about it. Anything that one can say is open to dispute or denial, but whatever one actually succeeds in doing is beyond argument. We have a pretty clear idea of what we are going to do. Once it is done, it won't need any explanation. However, you have got hold of the main principles. We are hauling around too much dead weight. It costs money to do that. The public has got to the point where it cannot pay for dead weight and live freight, too. One or the other must go.

Unnecessary Transferring of Loaded Cars

In a recent issue of the *Railway Age*, F. W. Brazier of the New York Central makes the following comments on present interchange practice:

"The question of unnecessary transferring of loaded cars has been discussed for years and no real action taken to stop the large number of cars from being transferred. The remedy I would suggest is one that would cut down at least 50 per cent of the so-called transfers, if it could be put into effect.

"It is not the fault of the car inspector who cuts out a loaded car for transfer that in his judgment is unsafe to run. Furthermore, I do not think any railroad today would stand for a vindictive car inspector cutting out cars unnecessarily. Our operating officials were greatly alarmed over the large number of cars that were being cut out for this purpose and wanted me personally to inspect cars at different points to see if the inspectors were justified in cutting them out. In almost all the cases I found the condition of the cars was such that the inspectors were justified in doing so. My greatest surprise was in many cases that the cars ever reached our terminals in such bad condition, being not only unsafe to run but unsafe for the lading.

"I could go into considerable detail but will simply give the following figures taken recently from our records for a period of 30 days: Cars cut out numbered 803; of these 750 were foreign cars. Of these cars 157 were all-steel or steel underframe with defective underframes and sills. Of the remainder, 502 cars had wooden sills, broken draft timbers, burst ends, etc., and the balance of the defects were broken hoppers, bulged ends and defective trucks. A large percentage of the cars were of light construction and must have been in bad order when they were loaded.

"The remedy is that no car should be loaded at a terminal that is not first inspected by a competent car inspector as to its fitness for the lading intended to be carried in it; it should also be inspected for the condition of the running parts.

"Some few years ago the MCB Association proposed that all cars should be inspected and carded for the kind of lading they were intended to carry, but no final action was taken as it required the co-operation of the transportation department. If the railroads would take some action to this end it would soon bring out the fact that there are many thousands of cars not fit to carry ordinary freight unless they are repaired before loading.

"It is true that cars have been known to be transferred and sent back to the receiving line; that no repairs were made and the cars were again loaded with freight and sent forward by a different road. Many cases have been brought to our attention where we have been offered the same car on which no repairs had been made; these we have rejected and cut out the second time. Then again in some cases on the first transfer of the car it was loaded with grain and in such a condition that it could not be repaired; it was transferred and sent back to the receiving line, where it could be loaded with lumber or bricks and be safe for that class of lading.

"The A. R. A. rules have defined what class of repairs should be made to cars under load so as to save the expense of liability of damage to freight in transfer, but it is utterly impossible in many cases to carry out A. R. A. rules and make repairs to cars under load, and consequently transfers must be made to save delay.

"Another point that should not be overlooked is that during federal control where cars were home on any railroad, we had a great many light capacity cars running over the system that never should have been allowed away from their home road. Until such time as the railroads can get their cars in first class condition and take more care in inspection before loading, we will continue to have numerous cases of transferring of loads . As suggested above, proper inspection of equipment before it is loaded will stop 50 per cent of the transfers."

FRANCO-CANADIAN EXHIBITION TRAIN.—To advertise the life and industries of France, a traveling exhibition, occupying eight cars, was recently shown in the principal cities of Canada. Its itinerary included Montreal, Three Rivers, Quebec and Toronto.

The eight exhibition coaches were assigned as follows: First coach, "La Pensee Francaise" (The French Thought), which included some of the finest treasures of French art and literature, as well as relics of the wars of France. Second and third coaches: Industrial exhibits, including travel, photography, civil engineering, mines and mineral products, mechanics, etc.

Fourth coach: "La Mode," including dresses, silks, laces, etc. Fifth coach: Leather industries, chemical products, drugs, perfumes, electrical appliances, brushes, toys. Sixth coach: Agricultural, horticultural and alimentary products. Seventh coach: Decorative art, bronzes, watches and clocks, jewelry and cutlery.

One of the New Sleepers Leaving Angus Car Shop

New Sleeping Cars for the Canadian Pacific

Composite Cars of 12-Section and Compartment Types Have Special Facilities for Comfort of Passengers

In handling its through passenger business the Canadian Pacific is confronted with some interesting problems. The road has the advantage of a fine scenic route and with a line extending from coast to coast, is well situated to secure transcontinental passengers. On the other hand, the competition for Pacific Coast traffic is very keen. Furthermore, the prospect of the journey of 2,886 miles between Vancouver and Montreal, requiring four and one half days to complete, might seem unpleasant to inexperienced travelers. The hotels conducted by the company at intervals along the route afford an opportunity for breaking up the journey, but even so the character of the traffic demands that the passenger equipment be of the highest grade, provided with every facility for the comfort of travelers. These conditions were carefully considered by the railroad in drawing up the designs of the latest order of 12-section and compartment sleeping cars. As a result the cars have been fitted with numerous conveniences not found in the ordinary sleeping car.

Interior of the Twelve-Section Sleeper

One of the notable features of the 12-section type sleeping cars is the provision made for the comfort of women passengers. This is particularly desirable in the transcontinental service on account of the length of the runs and because the proportion of women in tourist traffic is greater than where the cars are used principally for business trips. The ladies' dressing room is unusually commodious. It is fitted with three wash stands, each of which has a light above it, and is provided with a three panel, adjustable mirror. A long mirror is also fitted in the saloon door. One of the innovations which should contribute materially to the comfort of women passengers is a couch which has been installed in the dressing rooms on some of these cars. This provides an opportunity for relaxation that would seem highly desirable in view of the somewhat uncomfortable form of the usual sleeping car seat.

The new equipment consists of 69 sleeping cars, 56 of the 12-section type and 13 of the 10-compartment type. All the cars are constructed with steel frames and wood interior finish. The frames and trucks were built by the Canadian Car & Foundry Company at Montreal and the interior fittings were applied at the Angus shops of the Canadian Pacific.

On account of the special features of the design, the 12-section sleeping cars are extremely long, the length over the

body and sills being 75 ft. 6 in., and the coupled length 83 ft. 10½ in. The truck centers are spaced 59 ft. 6 in. apart and the wheel base is 70 ft. 6 in. The height from the rail to the top of the roof at the center is 14 ft. ¾ in. and the extreme height, from the rail to the top of the heater jack, 14 ft. 6½ in. The width at the eaves is 10 ft. 1½ in. and over the side sheets 9 ft. 10 in. The average weight of the cars is 173,400 lb.

The underframe is built with a deep fish belly center sill and Z-bar side sills. The center sill has a maximum depth of 30 in. between crossbearers for a distance of 28 feet and is 15 in. deep at centerplate. The web plates are 5/16 in. thick and are spaced 16 in. apart. At the bottom they are reinforced by two 3 in. by 3 in. by ⅜ in. angles on each plate, while the stiffening at the top consists of one 6 in. by 4 in. by ⅝ in. angle placed outside each plate with the short flange horizontal. A top cover plate 30 in. wide by 9/16 in. thick extends continuously for practically the full length of the sill, the ends reaching just beyond the door posts.

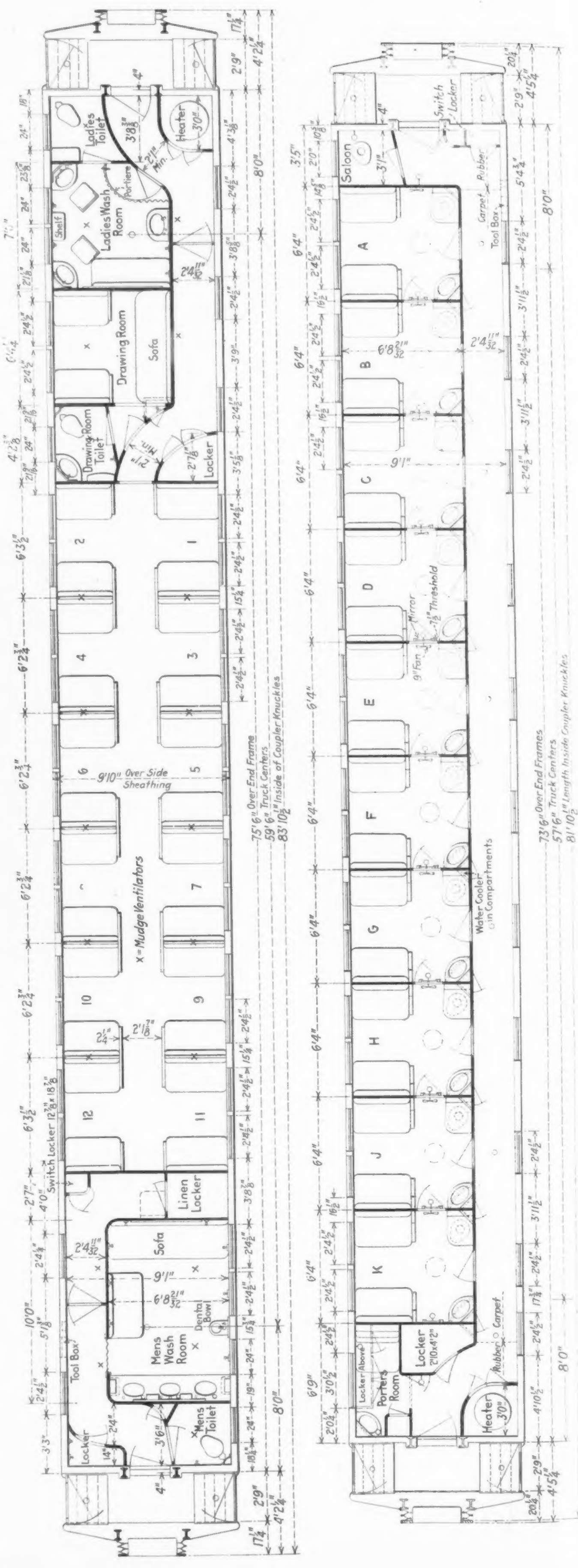
The body bolsters are of the double type commonly used with six wheel trucks, of built up construction, the two arms being 4 ft. 8 in. apart. The cross bearers, which are spaced 15 ft. 9 in. from the center plate, are also built up of pressings reinforced with angles and top and bottom cover plates,

The Dressing Room Is Designed to Insure Comfort for Women Travelers

the construction being shown in the cross sectional drawing. The floor beams are pressed from 5/16 in. plate, the spacing varying from 16 in. to 3 ft. 1⅜ in. The side sills are each made up of a 5 in. 11.6 lb. Z-bar and a 3 in. by 2½ in. by ¼ in. angle. The body end sill is a 5/16 in. pressing. An end cover plate, 5/16 in. thick and 22 in. wide, extends across the underframe at each end. At the bolsters there are also ¼ in. by 5 ft. 6 in. by 8 ft. 11 in. cover plates. The remainder of the floor is covered with 1/16 in. floor plates, which overlap the centersill cover plate on each side and fit over the floor beams and side sill.

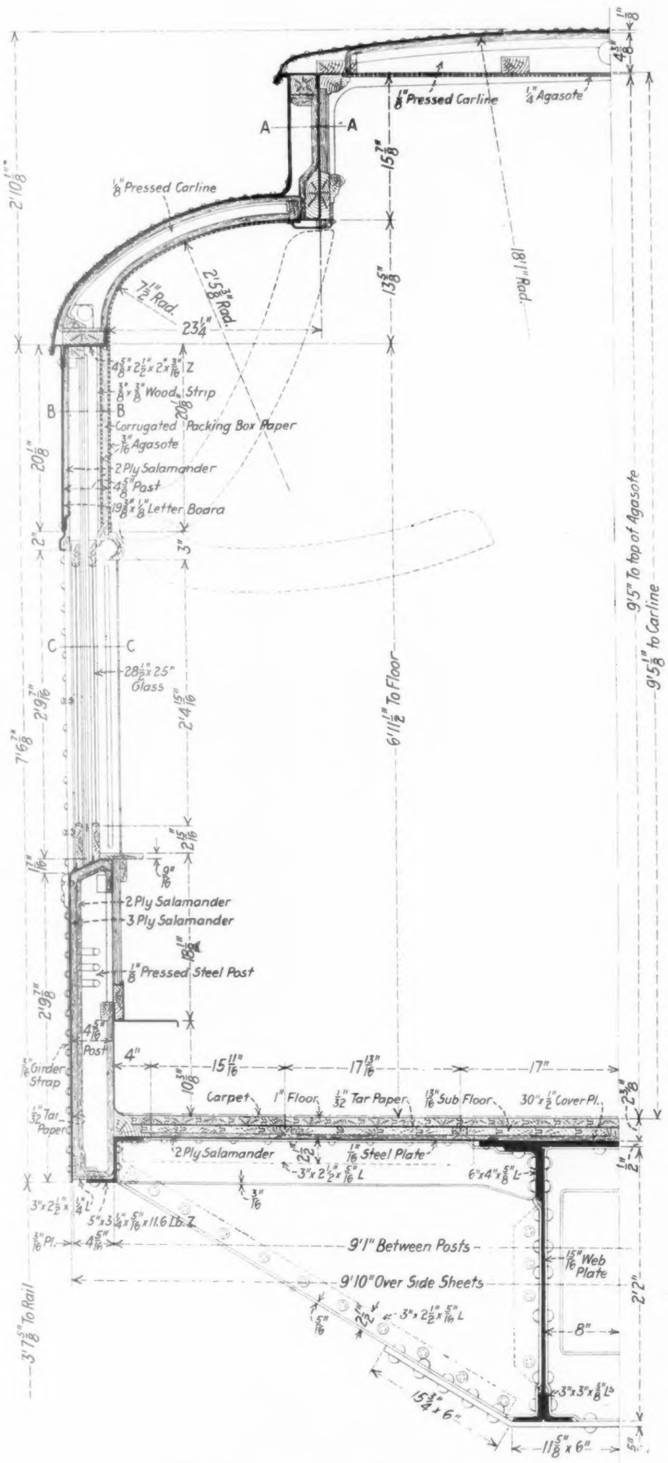
Side Frame

The side posts are of two types, those at the piers being of U-sections made right and left, the sheets being riveted to the flanges. The center pier posts are of a deeper U-section, the web being turned toward the outside of the car. The side plate is a Z-bar, 2 in. by 2½ in. by 4⅝ in. by 3/16 in. and is made continuous from end to end. The carlines are pressed of ⅛ in. steel. The lower carlines, which are continuous across the lower deck and up the side of the clerestory, are of ⅛ in. steel plate of U section, irregularly spaced at intervals of about two feet. A Z-shaped deck plate ⅛ in. thick is



Floor Plans of the Twelve-Section and Ten-Compartment Cars

fastened to the inside of the clerestory. The upper carlines are of ⅛ in. steel of Z section, 4⅜ in. high at the center and are placed directly above the lower deck carlines wherever possible. They are riveted to the inside deck plate and to the lower carlines. The body corner posts are built up of a 3 in. by 4 in. angle forming the corner with a 4 in. by 3 in. by 3 in. Z-bar riveted to the inwardly extending flange of the



Transverse Section Through the Car Body

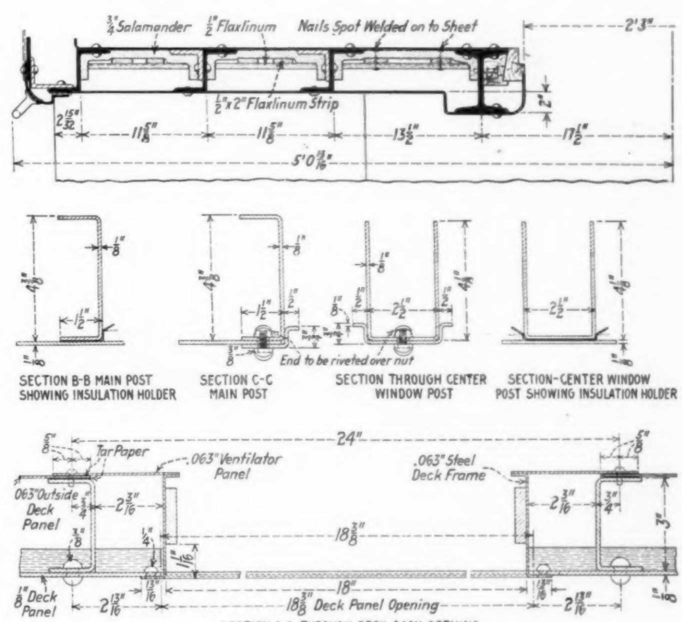
angle and forming a point of attachment for the end plates. The door posts are 6 in. I-beams to which wooden door frames are fitted. There are two intermediate posts on each side made up of 4 in. by 3 in. by 3 in. Z-bars, reinforced up to about two feet above the floor by 3 in. by 3 in. angles. The vestibule diaphragm posts are of 6 in. I-beams and are braced to the end posts of the body by 6 in. channels. The vestibule corner posts are made up of pressed steel with a wood filler.

The outside plates below the windows are 3/16 in. thick and meet the window ledge under the belt rail. The letter board and the pier plates are ⅛ in. thick and the outer deck plates 1/16 in. thick. The roof sheets are 1/16 in. thick excepting the hood sheets, which are No. 12 gage galvanized.

The exterior of the cars is finished in Tuscan red, the railway company's standard colors.

Interior Finish

The fittings in the interior of the car have been designed to give a pleasing appearance and also to afford adequate insulation for the extremely cold weather encountered in Canada. Three thicknesses of insulation are used in the side walls and two thicknesses in the roof and the deck. The method of fastening the insulation in the deck is worthy of mention. Wire nails are attached to the sheets by spot welding the heads. The insulation is driven over the nails which are then bent over. The floor has one layer of insulation over which a double wood floor is laid, except in the passageways which have rubber floors and the saloons where tile is used. Steel plates form the inside of the wall up to the seat level and a



Horizontal Sections Through the Car Body

third layer of the Salamander insulation is carried up to that point. The inside of the walls above are covered with wood wainscoting up to the lower edge of the berths. The side walls within the berths and the headlining are of Agasote. The berths, the deck molding and the interior partitions are of wood.

All the woodwork is mahogany or mahogany finished, except in the men's smoking room where either English oak or black walnut has been used. All parts above the deck molding are painted greenish gray. Little ornamentation is used. The ceiling and deck panels have a conventional border and marquetry borders are set into the berths and bulkheads. The seats are upholstered in green figured friezette plush and the carpet also is green. In the staterooms Biltmore plush is used for upholstery.

The men's smoking compartment has three wash basins, a dental lavatory and seats for six persons, upholstered in leather. The entrance to the men's saloon is from the hall instead of through the smoking room.

The cars are heated by a combined vapor and hot water system with a Frumveller heater. The main piping has separate controls for each side of the car, for the stateroom and

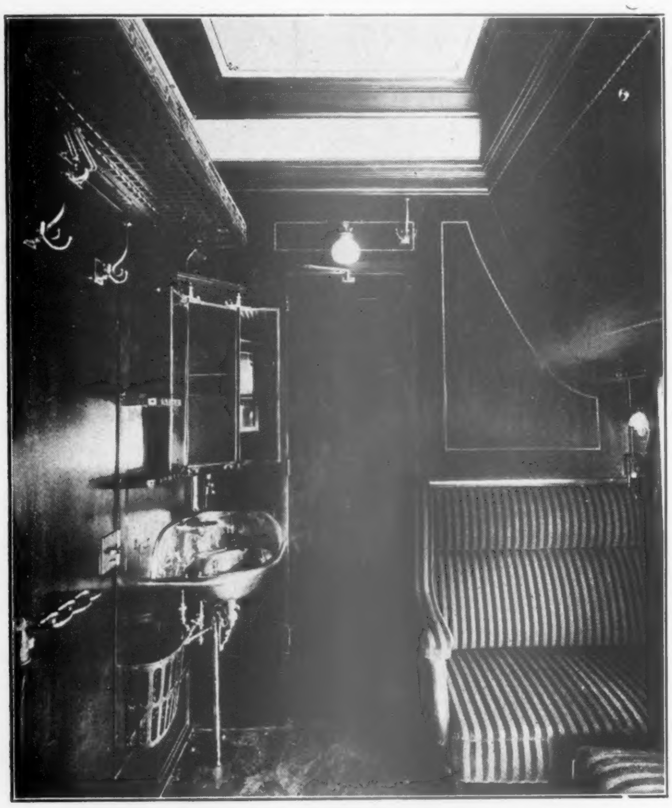
the smoking and dressing rooms. Additional heating pipes are provided which have individual regulation for each section. Twenty-one Mudge ventilators are applied to insure adequate air circulation.

The lighting systems are of the Safety and Stone-Franklin types. The batteries have a capacity of 600 ampere hours. The main lighting fixtures have semi-opaque bowls, five of this type being used over the berths and one in the stateroom. The usual arrangement of small lamps in the berths and aisle night lights is followed. The smoking room is fitted with a two-light ceiling cluster and individual lamps over the mirrors, while in the ladies' dressing room wall fixtures only are used. The conduits for the piping are set inside the walls and the roof.

The cars are carried on Commonwealth six-wheel trucks, with 5 in. by 9 in. journals, having a wheel base of 11 ft. They are equipped with steel tired wheels and clasp brakes. The brake equipment is the schedule LN1812 designed for 90 per cent braking power. Miner hand brakes are used with a sheave wheel between the drum and the brake rigging to increase the force.

Compartment Cars

In general design the compartment cars are quite similar to the 12-section sleeping cars. The body is two feet shorter



Interior of One of the Compartments

and changes have been made in the spacing of posts to fit the altered floor plan. The interior woodwork is mahogany and the upholstery is Biltmore plush. Care has been taken in fitting the compartments to afford the maximum of comfort and convenience for the passengers. Individual regulation of heat and ventilation is provided. A long baggage rack, an umbrella rack, trays and numerous hooks are facilities that will appeal to the traveler with a large amount of luggage. Space at one end of the car has been utilized for a saloon while the other end carries the heater, linen locker and porter's room.

Both types of cars are equipped with safety appliances to meet the United States and Canadian standards. The handholds are attached so that they can be removed without disturbing the car framing, flooring or lining. Other appliances include bottom operating lower couplers, Miner A5P draft gear, Acme single web type diaphragms with rubber hoods, JM expander rings, Miner buffer and Woods single roller side bearings.

Coopering Cars for Grain

E. F. Ford, freight service inspector of the Chicago, Burlington & Quincy, has prepared some useful suggestions to grain shippers, calling attention to the need for careful inspection and preparation of grain cars, particularly at this time when over $4,000,000 out of a total of $6,000,000 paid out in loss and damage claims to grain, represents shortages resulting from causes other than wrecks. Mr. Ford says:

It has been our experience that grain can be moved practically without leakage by the right kind of teamwork on the part of shipper and railroad agent. Our statistics show as many as 100 to 200 cars from a certain station forwarded without a claim, while a nearby station forwarded half as many cars and had several claims, both stations being on the same railroad and the empty cars allotted by the same car distributor and set to elevators by the same train crews.

Investigation of such cases invariably develops that at the station having such good results, there is teamwork on the part of shipper and railroad agent in the inspection and coopering of cars, while at the station having unsatisfactory results we find there is little or no co-operation between shipper and agent. The local will set out an empty car, and if the agent sees a "Fit for Grain" tag on it he has it set for loading, shipper does what he regards a good job of coopering and the car is loaded. Three heads are better than one, and if the shipper would request the railway agent to look the car over after it has been coopered, in many instances defects which escaped the previous inspection would be discovered.

A shipper should not assume that a car is fit for loading simply because a "Fit for Grain" tag is on it. Car inspectors, like the rest of us, are liable to error. The safest course is for the local agent and the shipper to carefully inspect the car before loading regardless of the tag.

Reject any car with weak or broken door or end posts, leaky roof, creosote or oil-soaked floor, or if it is an old car which in your judgment cannot be made grain-tight by a fair amount of coopering.

Look carefully for cracks at side walls caused by short floor boards and cover tightly with paper or burlap, cleated.

Cover tightly in the same manner all defective places found in car lining, being particular to cover with tight fitting boards end-door openings.

King pins and draft bolts should be covered and cleated.

Grain lining at top and belt rail should be carefully inspected and where not absolutely grain-tight it should be made so by use of paper or burlap calking.

Place paper pads tacked to door post to give smooth surface and tight fit to grain doors, which should be nailed with 12d nails two to each end of each grain door. This is important, since experience proves that 12d nails are the exact size required for safety—this nail gives 1¼ in. penetration into the oak door post and will hold the door in its place through any rough handling car might encounter. Smaller nails give trouble and larger nails require chopping out and destruction of grain door at unloading point.

Cover with paper all grain door cracks and where loading heavier than 60,000 lb., reinforce with an extra door across joints between first, second and third door joints.

Go over the outside of car and securely fasten with cement-coated nails any loose sheathing boards you may find.

Prevent any possible leakage where sills have rotted by using burlap nailed to bottom of sill and secure sheathing by nailing a strip of board over it at the rotted sill.

Make Car Owners' Responsibility Complete*

Reduce Handling Line Liability Under Interchange Rules—Include a Profit in Billing Prices

BY C. J. WYMER
Superintendent Car Department, Chicago & Eastern Illinois

SHOULD not the present A. R. A. Interchange Rules be revised to eliminate dual responsibility, making car owners responsible for all defects?

This should be qualified to the extent that it might be desirable to make the handling line responsible for extensive accident damage and departures from important standards on foreign cars. It would be desirable to maintain a limit of repairs requiring the authority of the owner to prevent a greater repair expense than he might wish to make on certain equipment.

The present interchange rules make a division of repairable defects as between owning and handling line responsibility, many of which, in our opinion, are of such minor importance as not to justify the attention they require properly to place the responsibility as defined. Furthermore a very large majority of the defect cards which are issued in interchange are for old damage, indicating that the penalty it is supposed to inflict as punishment for what, under the rules, is considered the misuse of equipment, does not assess against the guilty party. Our conclusion is that punishing the innocent does not decrease crime.

Some have argued that it is essential to have handling line defects as a means of avoiding useless damage to equipment through rough handling by switchmen and train crews, believing they are more careful when handling foreign line equipment than they would otherwise be on account of the liability for certain damage being assessed against the employing company. But the foreign car is handled along with the home car and any effort to give the home car preferred handling would result in the foreign car receiving the same treatment. Then, again, the average train man does not know where the lines of responsibility are drawn, if he even knows they exist at all, and he is interested in numbers and initials of cars only for the proper movement of them in line with his duties.

The first interchange rule reads as follows: "Each railroad is responsible for the condition of all cars on its line, and must give to all equal care as to inspection and repairs, regardless of responsibility for expense of repairs." May we ask what is the intent of this requirement of the rule and whether it is performing its function? It is clearly the intent of the rule to require that a car be maintained for service while on foreign rails equally as well as it would be on its home rails. We do not believe that any concrete argument need be presented in support of a statement that the rule is not complied with, as it is a well-known fact that most cars, if they are away from their home rails for an extended length of time, return as cripples if they return at all.

Accepting the above statement as a fact as to the intent of the rule and also as to its ineffectiveness, the next questions most natural to arise are, "Why is it not effective?" and "What right has it to exist?"

It has a perfect right to exist because it is correct in principle, and if the money which it costs the railroads annually for the movement over their rails of foreign equipment in bad order because it was not maintained away from home and not sufficiently maintained at home, could be known it would be a surprising amount. Added to the other vast amount which would be saved in claims arising from improperly maintained equipment, it would be sufficient to cause every railroad man to do his part in overcoming this needless expense.

It may be argued with some merit that the owning road is best equipped for repairing its own cars since it is supplied with material peculiar to their construction. Admitting that this argument has some value, represents only a small part of the upkeep of the equipment if the "stitch in time" were applied; and, again, when we find that materials common to all railroads are not maintained, we are forced to conclude that it is not of prime importance. If railroad cars were constructed along more uniform lines in certain details, this objection would be practically removed, and a large reduction in material supplies on hand could be made.

There is lack of adequate incentive to act as Rule 1 requires. Outside of defense of home and country, it is natural for mankind to expect some material reward for service rendered, and the way to create this incentive would be to revise the A. R. A. Rules to the extent that they would represent a substantial profit for material and labor expended in making repairs. Were this done, it is our belief that it would not only have a far-reaching effect in securing prompt repairs to foreign equipment, but would cause a better maintenance of the home cars. The handling line would be willing and anxious to repair foreign cars on account of the profit to the company, and would be equally anxious to maintain its own equipment in such manner as to require the minimum attention in the way of repairs while away from home to prevent paying a premium to other railroads for their maintenance. It would result, further, in better initial construction in order that cars would perform their service with the minimum amount of repair attention during their existence. It has too often been true that substantial construction has been sacrificed to reduce initial cost.

There are still further benefits which should be derived from the proposed changes in the way of labor and stationery saving. The inspection forces now employed at interchange points for making technical inspection and records to conform to the intent of the rules could be greatly reduced, and this wasted labor, made necessary on account of present rules, diverted to the actual repair of equipment. Much time is consumed by officials, who are responsible for their enforcement, in an effort to familiarize themselves and their employees with the requirements of the rules which very consistently change at least once each year. There is a constant flow of correspondence over the railroad and with other railroads on account of the dual responsibility of the interchange rules, which would cease, thus saving much time of officials and clerks as well as stationery. These energies could be directed with better results along constructive lines.

Inspection of equipment in our judgment, should be confined to the determining of three conditions: (1) To insure safe movement on the railroad; (2) To insure safety for train men, and (3) To provide for the protection to commodities.

With delivering line responsibilities eliminated the inspection at interchange points would much better conform to the above requirements and the work be performed with greater dispatch. At present, special effort is made to locate

*Abstract of a paper read before the Western Railway Club, Chicago, October 17, 1921.

whatever delivering line responsibilities the car may carry, which may be only a few raked side sheathing that in reality only mar rather than disqualify a car for service. More serious defects, such as worn-out wheels, defective brake beams, etc., that may cause an accident resulting in the destruction of many dollars' worth of property and possibly the loss of human lives, are overlooked. The movement of cars is often retarded at interchange points, delaying shipments and creating switching expense, which would not occur if there were but one responsibility, *i. e.*, car owners'.

The above-outlined plan could not be put into effect in fairness to car-owners without giving full consideration to their interest in the way of an adequate rental charge for the use of their equipment while on foreign lines. This consideration would be an absolute necessity in connection with the other changes suggested and without it it would mean great sacrifices to present and future owners of large amounts of equipment. It would also be necessary for the purpose of encouraging the ownership of equipment, as it can be readily seen that with the repairs placed on a profit basis and the rental charge for the use of equipment low, it would be to the advantage of any railroad to own just as few cars as essential to the conduct of its business over and above the equipment it was able to obtain from other lines. Furthermore, there would be no disposition on the part of such railroads to release equipment as long as it could possibly be made use of to advantage.

A high rental charge should also have the effect of moving equipment to the home line during depressions in business. The rental charge for the use of equipment should be sufficient to return to the car-owner during the life of his equipment the original investment, maintenance cost and other expenses incident to ownership, and a fair interest return.

Private owners of equipment might consider that the plan suggested would work a hardship on them on account of having no opportunity to participate in the repairs of equipment belonging to other companies, but they would be fully protected if a suitable rental charge for the use of their equipment were provided.

We are not in a position to say what would be the proper labor, material and rental charges to carry out the plan outlined. If considered favorably, a thorough investigation of the subject would be required by competent accountants to arrive at these charges properly.

We appreciate, with repair forces reduced to a minimum on all railroads, and considering the present general condition of all equipment that no substantial progress could be made in bringing about a radical improvement in the present condition of cars, without increased application of labor and material. But some of the advantages of the plan suggested would immediately accrue without any attending disadvantages, and it is hoped that present conditions will not always exist. When conditions do become favorable, the benefits of the plan would become effective in all the various channels outlined. These recommendations represent rather radical changes from present methods, but we believe that these or other changes no less radical are essential to bring about a more substantial maintenance of equipment and the cutting loose from expensive red-tape systems, and will eventually come—so why not now?

A Check on Rough Handling of Cars

Road service tests on a device designed to keep a record of the rough handling of cars have been carried to the point which is said to have definitely established the practicability of the device. They have also shown that most of the rough handling to which cars are subjected occurs in yards during the makeup and breakup of trains and not, as has been claimed by some, in the handling of trains on the road as a consequence of slack adjustments. The particular value of this device arises from the possibility of effecting an appreciable reduction in rough handling.

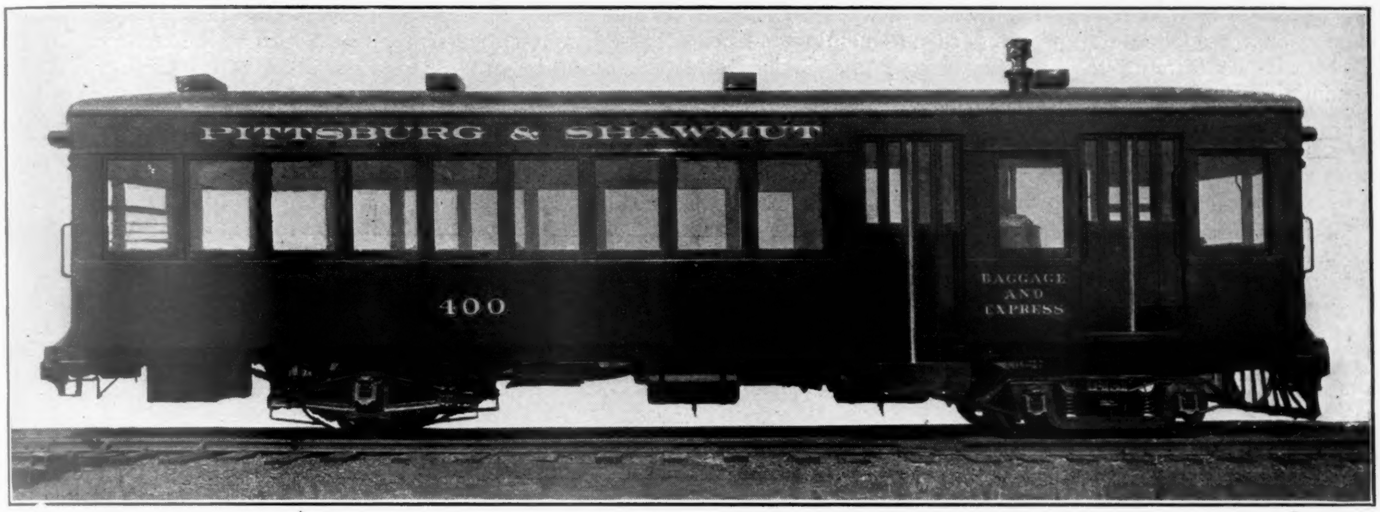
The device consists of a spring motor or clock which winds a tape or registering chart graduated to 15-min. periods and designed to give a continuous record over a period of 10 days. This tape records the movement of a pencil attached to a weight which moves between suitable guides under the control of two springs. Any sudden impulse or impact given to the device gives the weight a vibratory motion and thus records marks in a crosswise direction on the tape. The length of these lines, as indicating the distance that the weight has been moved from the neutral position near the center of the tape, is a measure of the amount of impact sustained.

The first problem which it was necessary to settle before a successful test could be inaugurated was that of determining the limit of rough handling in terms of vibration on the chart of the impact register. This was accomplished through a series of tests conducted with a view of creating actual cases of rough handling and observing the resulting vibration on the chart of the impact register. Both loaded and empty cars were used, with wood and steel underframes. These were allowed to couple at speeds varying from 2 to 10 miles an hour. Each case was considered from the standpoint of possible damage to a car of merchandise and was accordingly adjudged as being a case of rough handling or permissible handling and the limit of rough handling was decided to be between two and three miles an hour speed at the time of impact.

After the chart graduation test had been completed, a number of machines were put into use in through merchandise cars operated by the Chicago, Milwaukee & St. Paul between Chicago, Kansas City, Milwaukee, Madison, Minneapolis and Mason City. The machines were in cars operated on a regular loading schedule and were handled at destination by the agent in charge. No traveling inspector accompanied the machines, but their records were removed by the receiving agents and mailed to the general office for investigation and tabulation. The movement of the machines was not advertised and train crews did not know at any time when they might be handling the register. Each case of rough handling which resulted was taken up with the superintendent on whose division it occurred and the crew responsible disciplined therefor.

Studies of records made with the increment recorder indicate, as stated in the opening paragraph, that 97 per cent of the rough handling cases actually occur in yards. The question has been raised whether it is within the limits of reason to expect that cars may be handled under the conditions imposed on railway operation without a certain amount of rough handling. In answer to this it is noted from the record obtained in the tests that 27 out of 111 cars under observation moved from origin to destination over an aggregate distance of 10,000 car miles without a single case of rough handling. There are also repeated instances where cars moving over exactly the same route received widely varying treatment. It is, therefore, estimated that if 24 per cent of the cars can be handled properly under present conditions of transportation with no rigid disciplinary measures in effect, the enforcing of proper discipline would enable the handling of at least 70 per cent of the equipment in the same manner. The impact recorders described above were developed and are being manufactured by the Railway Impact Register Company, Belleville, Ill.

ANTI-RAILWAY PROPAGANDA IN ITALY.—An Italian journal is reported as estimating that if the 200,000 railway workers of that country were each employed in driving 10-ton trucks 8 hours a day for 300 days a year, five times as many ton miles would be carried as by the Italian railways now. The number of employees necessary for repairing trucks and for loading and unloading freight are not mentioned.

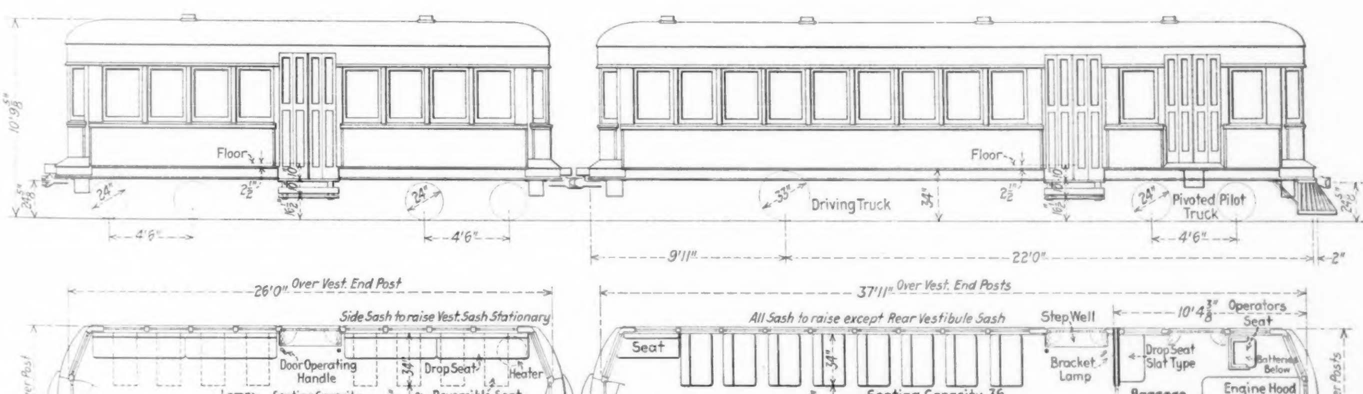


One of Three Bowen Motor Cars Recently Delivered to the Pittsburg & Shawmut

Bowen Gasoline Motor Driven Passenger Car

Arrangement of Power Transmission System and Rear Truck Are Features of Design

A GASOLINE motor driven passenger car particularly adapted for use on branch or short line steam railways, which involves a unique combination of standard automobile practice with the essential features of railway rolling stock design, has recently been developed by the Bowen Motor Railways Corporation, St. Louis, Mo. The car shown in the illustration is one of three for the Pittsburg & Shawmut, the construction of which was recently completed by the Barney & Smith Car Company. The features of construction of particular interest in this car are the arrangement of the power transmission system and the design of the rear truck, through which the power is transmitted to the rail.



Elevation and Floor Plan of Motor Car and Trailer

The power plant is a four-cylinder automobile motor with 4½-in. by 6-in. cylinders, capable of developing 62 brake horsepower at 1,600 revolutions per minute, which is attached directly to the underframe. From the motor clutch, which follows the lines of automobile practice, power is transmitted by means of a longitudinal shaft to the main transmission, which provides for four speeds. The ratio of shaft speed at the driven and driving ends of this transmission vary from 4.99 to 1 for the first speed to 1 to 1 for the fourth or high speed. From this transmission power is again transmitted through a longitudinal shaft to an auxiliary reversing transmission, which provides a speed ratio of 1 to 1 in forward motion and of 1.085 to 1 in reverse. From this transmission to the rear axle gear case power is again transmitted by a longitudinal shaft.

The cast steel gear housing of the rear axle is built in two sections to permit easy inspection and repair of all gears and pinions. This construction makes it unnecessary to disassemble the truck in case any gears are to be removed. The arrangement of the combination bevel and spur gears is such that the gear ratio of the drive and, therefore, the car speed can be changed at any time by replacing the bevel gear set by another of a different ratio. From the motor to

the rear axle gear case the transmission devices and shaft connections throughout follow standard automobile practice, the details conforming to the standards of the Society of Automotive Engineers.

Compressed air to operate the brakes is provided by an air compressor mechanically driven by a longitudinal shaft from a power take-off located at the main transmission.

The two-wheel driving truck under the rear end of the car is of unique construction, combining the requirements of a fixed angular relationship between the center line of the axle and the center line of the car with a complete unity of construction which permits the rear axle with the brake rigging and gear case to be removed from the car intact. This truck is built up of cast steel side frames which are joined at the ends with cast steel cross pieces of I-section. The side frames are provided with pedestals for standard M. C. B. journal boxes. The gear case which surrounds the center of the axle is rigidly supported by two longitudinal members of rolled channel section, bolted to the underside of the truck frame end pieces. Lugs on the truck frame provide for the support of two brake beams, one in front and one at the rear of the driving wheels, which are fitted with M. C. B. standard brake heads and brake shoes. These are

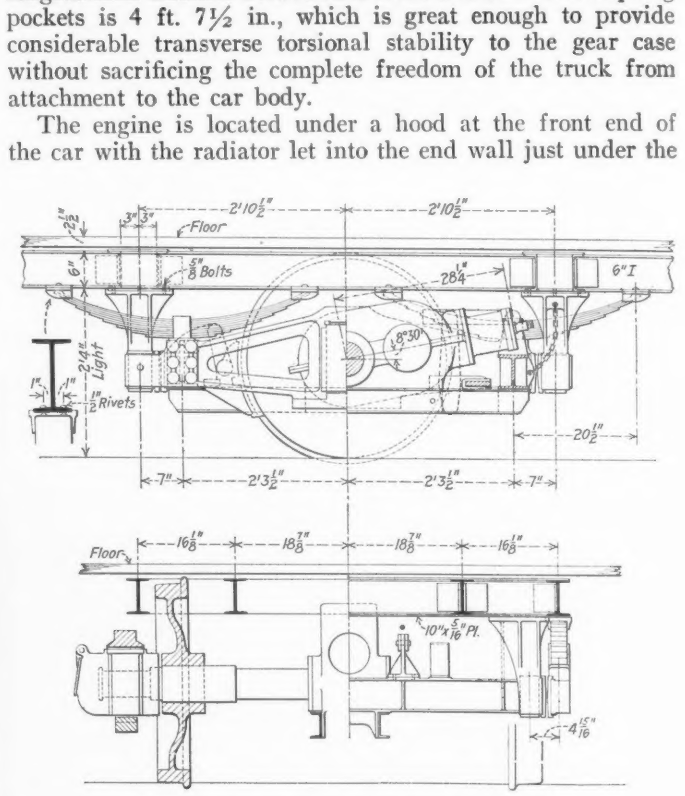
Interior View of Passenger Compartment

connected with simple clasp brake rigging, operated by Westinghouse semi-automatic air brake equipment.

The alinement of the truck with respect to the car body is maintained by four column castings bolted to the underside of the car underframe. These castings are provided with vertical wearing shoes on their inside transverse faces and outside longitudinal faces which bear against corresponding wearing shoes secured to the end pieces of the truck frame and to projections from the side frames. Lateral alinement is thus maintained at four points on the truck frame and the driving thrust in either direction is transmitted to the car body at two points through these shoes, which are free to move vertically with respect to each other.

The weight of the car body is transmitted to this truck frame through four semi-elliptic springs the center bands of which rest in suitable pockets in the truck frame and the ends of which bear against small flanged wearing shoes riveted to the underside of the car body underframe. The longitudinal distance between the front and back truck spring pockets is 4 ft. 7½ in., which is great enough to provide considerable transverse torsional stability to the gear case without sacrificing the complete freedom of the truck from attachment to the car body.

The engine is located under a hood at the front end of the car with the radiator let into the end wall just under the



Details of Rear Axle and Truck

front window. The hood is asbestos lined in order to permit the space over the engine to be filled with small baggage or express packages, thus conserving baggage room floor space.

With a 10-ft. 4⅜-in. baggage compartment and 36-in.

Details of Operation of the Bowen Motor Car

Month	March	April	May
Days operated	31	30	31
Total miles	3,987	3,960	4,092
Passengers carried	4,240	3,721	2,780
Gross revenue	$1,215.82	$1,146.44	$844.40
Gallons of gas	677	599	620
Cost of Gas	$169.25	$144.76	$168.00
Cost of oil, grease and coal	11.16	18.53	15.00
Operating labor	260.00	207.80	183.68
Maintenance labor and parts	16.35	7.30	13.20
Total expense	$461.71	$378.39	$379.88
Net cash earnings	$754.11	$768.05	$464.52
Summary			
Gross earnings per mile	.305	.289	.206
Cost of operation per mile	.115	.095	.092
Net earnings per mile	.190	.194	.114

The population on the line of above road is 175 per mile.

door openings at the sides of the passenger compartment, the car has a seating capacity of 36 persons. Other arrangements can be used seating as many as 43 passengers. The power plant is considered large enough to handle a trailer on grades not exceeding three per cent and a design has been developed for such a car 27 ft. 4 in. long over the channel undersills, which may be provided either with reversible seats or longitudinal drop seats. In the former case a seating capacity of 32 may be provided while in the latter case the seating capacity is 24. With the exception of the interior finish, the entire construction is of steel, the underframe or chassis, the longitudinal members of which are 6

ft. I-beams, being completely standardized. Changes in the body construction and arrangement may be made to suit local requirements. The car illustrated weighs 28,000 lb. complete.

The first car built by the Bowen Motor Railways Corporation was placed in service about three years ago. It has now operated over 175,000 miles and is still in service. Its performance was carefully analyzed and while no fundamental defects developed, it was considered advisable to change the later design by making changes in the size and design of the car body.

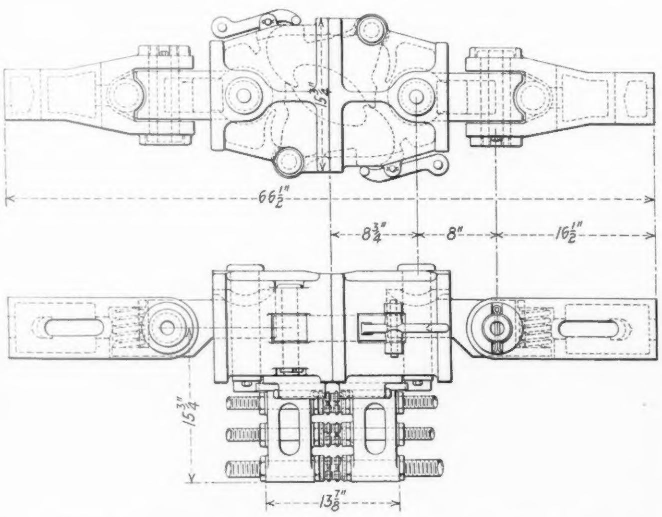
Records of the operation of these cars indicate that they can be run at a cost of about 18 cents per train mile where the railroad train service wage scale is in effect, or 12 cents per mile under non-union conditions. Further details of the cost of operation of a Bowen motor car on the Westfield Railroad are given in a tabulation herewith.

While this car is designed particularly for handling passengers, express, mail and baggage on short and branch line steam railways, it was also adapted for use on suburban electric lines where the cost of power is excessive. In new construction, the gasoline motor cars have important advantages over electric cars, eliminating the necessity for overhead wiring and the extra cost for the installation and maintenance of power stations.

A Combined Car Coupler and Hose Connector

Operating Principle and Construction of Coupler Differ Radically from Present Standard

A COMBINED car coupler and automatic steam and air hose connector in the design of which a complete departure has been made from the operating principle of the present standard vertical plane coupler, has recently been placed in service on a number of steam railway passenger cars. The device, which has been developed by the Universal Car and Hose Coupler Company, St. Louis, Mo., provides for no vertical adjustment between the coupler



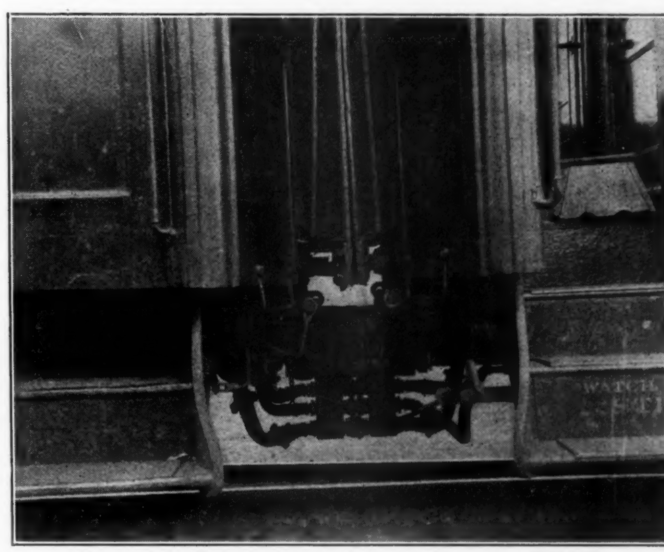
General Arrangement of the Universal Car and Hose Coupler

heads and the hose connector blocks are directly connected to the car coupler head.

The operating principle of the coupler is clearly shown in the illustrations. From the drawing, which shows two of the devices coupled together, it will be seen that vertical and lateral adjustments are provided for by an intermediate section of the draw bar, hinged to the main draw bar by a larger horizontal pin. To the end of this the coupler head in turn is attached by a vertical pin connection. When uncoupled the coupler head is supported approximately in a horizontal position by means of a vertical coil spring acting on an extension from the lower side of the intermediate draw bar.

The coupler head presents a rectangular bearing face measuring approximately 11 in. vertically by 16 in. wide over all, the width of the bearing surface being about 1¾ in. From the left half of the rectangle enclosed by this bearing projects a tongue which is tapered both horizontally and vertically to provide for automatically bringing the coupler heads into alinement as they approach each other. Within the right half of this rectangular is a pocket to receive the tongue of the opposing coupler. The inside vertical face of this tongue is recessed to form a standard M. C. B. knuckle contour for use in interchange with standard equipment. A horizontal opening through the tongue is also provided for the so-called locking lug or latch which is attached to the coupler head by a 1⅝-in. knuckle pin. A cylindrical pocket 8 in. long by 1⅛ in. in diameter is drilled into the locking lug and in this recess is placed a 1-in. coil spring 5½ ins. long acting on a 1-in. pin projecting beyond the back side of the lug. This pin acting against an interior surface of the coupler head automatically maintains the lug in its locking position in which the locking or latch portion of the lug projects outward through the side wall of the adjoining coupler head when the two heads are locked.

In coupling, as the bearing faces of the adjoining couplers

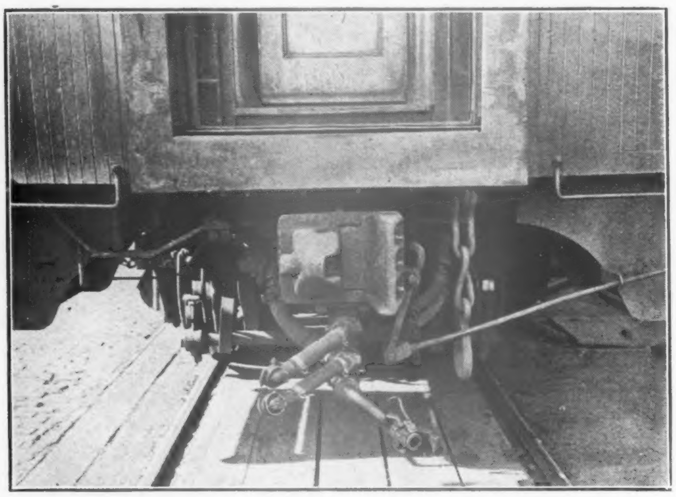


Universal Couplers in Passenger Service

are gathered into alinement, each automatically opens the latch of the adjoining head against the spring compression until the bearing faces come in contact. Each latch then closes into an opening through the side wall of the adjoining coupler head, thus locking the two heads together. In uncoupling, lateral pressure is brought against the face of one of the latches where it projects through the wall of the adjoining coupler head, by means of a suitable lever ar-

rangement, thus pushing it back to clear the locking face of the coupler head with which it is engaged. The interior surface of the latch end of the locking lug engages a tail projection on the adjoining lug in such a manner that the one operation moves both lugs to the release position.

Owing to the fact that the adjoining coupler heads are permitted no freedom of movement relative to each other when coupled the opposed connector blocks are attached directly to the coupler heads, which, thus perform the function of alinement for the hose connections. All that is required, therefore, in the hose connector feature are end gasket connections located on the vertical center line of the coupler at fixed distances below its horizontal center line. These connections project beyond the face of the coupler, in which position they are maintained by coil springs housed within a connector bracket which is attached to the lower face of the coupler head. When coupled, the compression on these springs maintains a tight joint between the adjoining gaskets. To the rear end of the connector pipes



Universal Coupler with Guard Arm Applied for Interchange with the Standard Car and Hose Couplers.

are secured short hose connections lacing from the various train line pipes. The gasket ends of the connector pipes are arranged to receive adapter couplings, by which adapter hose can be readily attached for use in interchange with standard equipment.

To provide for interchange with standard vertical plane couplers a casting, corresponding in contour with the guard arm of the standard coupler, has been designed to fit into the receiving pocket of the Universal coupler, to which it is secured by a lug on its lower face. This lug fits in a corresponding opening through the bottom of the coupler head. One of the illustrations shows this casting in place.

The principle purposes in the design of this coupler are to eliminate the necessity for going between cars to line up coupler heads or to couple air and steam; to interlock the two coupler heads in such a way that the draft stresses will be uniformly distributed over the head; to eliminate slack between the coupler heads and to keep them in correct alinement on curves as well as on straight track.

A Chemist in a Freight Car

BY H. J. FORCE

Of the enormous total bill for loss and damage of freight on the railroads of the country—over 100 millions of dollars yearly—an appreciable percentage is due to large losses on merchandise which is damaged by coming in contact with chemicals and acids. Many carloads of sugar, flour, coffee and other similar commodities have been seriously damaged by being loaded into cars in which the floors were contaminated by various kinds of acids. In some cases not only were the lower layers of bags eaten or damaged, but also those on the side of the car were eaten and the contents of the bags spilled over the floor.

Strong alkalies of which the drums have been broken open or leaked have produced similar results.

Machinery with parts nickel plated or galvanized have been badly corroded by the fumes of muriatic acid which had penetrated the floors. Rugs, carpets, cotton goods in rolls, etc., have been in many cases eaten 1 or 2 inches, thereby practically ruining the entire roll.

Cars which are contaminated with acid can be very easily detected. An acid car will in practically every case have the appearance of being oil-soaked or wet. Cars which are thoroughly dry or dusty have been found to be free of acid in nearly all cases. Blue litmus paper when placed in contact with acid will at once turn red; place a few drops of water upon the floor and lay the blue paper on the damp or wet place. In case the paper should not assume a reddish appearance red litmus paper should then be placed upon the floor. If the car is soaked with alkali the red paper will turn blue. Cars of this kind should be placarded "BAD ORDER," "ACID CAR" or "ALKALI CAR" and should in no case be used for loading any commodities which could be injuried or damaged by acid.

If there is no reaction to either the blue or the red paper the car is probably contaminated with oil, and should not be used for sugar, coffee, flour, dry goods, etc.

Cars which are badly contaminated by acid need a new floor or a new lining. Where only slightly damaged the acid can be removed by washing well with a hose and sprinkling with baking soda.

On the Lackawanna, careful inspection for acids and alkalies has eliminated damage claims of this class.

Vegetables, such as potatoes, cabbage, onions, etc., have been found to be badly damaged on the lower layers when loaded in cars contaminated with salt. Great care should be exercised in the selection of cars for food stuffs and no cars should be loaded with these products which are contaminated with acids, alkalies or salt.

Covering the floor of the car with paper or sawdust will have little effect when the car is badly contaminated with acids or alkalies.

PASSENGERS RIDING FREE on the Central Pennsylvania Division of the Pennsylvania Railroad are liable, if they don't "watch out," to receive from the conductor, when the train is filled, a small card bearing the following inscription: "PAY PASSENGERS ARE STANDING. It, therefore, seems appropriate to remind the holders of passes of their duty to refrain from occupying seats."

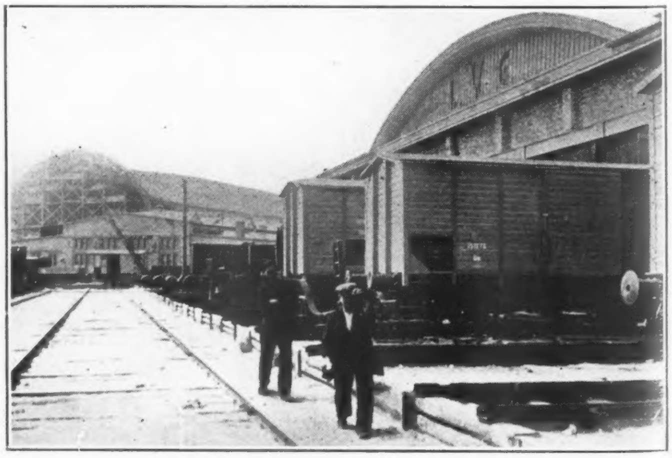


Photo by Underwood & Underwood

German Airdrome at Johannesthal Converted to a Car Shop.

Labor Board Lifts Piece Work Ban

The present labor crisis has been complicated by a decision of the Labor Board handed down on October 13 and containing drafts of 17 rules considered by the Board as just and reasonable rules for inclusion in all agreements between individual roads and their shop employees. One of these rules removes the present ban on piece work, and of the total of 17 rules, 10 have been so worded as to eliminate inefficient and uneconomical results caused by the application of the counterparts of these rules in the Shop Crafts' National Agreement. Seven rules of the National Agreements, Rules 8, 31, 61, 66, 67, 68 and 78, dealing respectively with Sunday work, seniority in departments, requirements for machinists, definition of "dead work," assignment of "dead work" forces to running repair work, machinists and helpers on wreck trains, and requirements for boilermakers, have been judged as just and reasonable by the Board and are made effective on October 16.

The new rules promulgated by the Board are as follows, the rule number corresponding with the similar rule in the National Agreements and the italic portion indicating the changes made by the Board:

Rule No. 1

Eight hours shall constitute a day's work. All employees coming under the provisions of this agreement, except as *otherwise* provided *in this schedule of rules, or as may hereafter be legally established between the carrier and the employees,* shall be paid on the hourly basis.

This rule is intended to remove the inhibition against piece work contained in rule 1 of the shop crafts' national agreement and to permit the question to be taken up for negotiation on any individual railroad in the manner prescribed by the Transportation Act.

Rule No. 2

(Rule adopted as substitute for Rules 2, 3, 4, 5, of the national agreement.)

There may be one, two, or three shifts employed. *The starting time of any shift shall be arranged by mutual understanding between the local officers and the employees' committee based on actual service requirements.*

The time and length of the lunch period shall be subject to mutual agreement.

Rule No. 18

When new jobs are created or vacancies occur in the respective crafts, the oldest employees in point of service shall, if sufficient ability is shown by trial, be given preference in filling such new jobs or any vacancies that may be desirable to them. All vacancies or new jobs created will be bulletined. Bulletins must be posted five (5) days before vacancies are filled permanently. Employees desiring to avail themselves of this rule will make application to the official in charge and a copy of the application will be given to the local chairman.

An employee exercising his seniority rights under this rule will do so without expense to the carrier; he will lose his right to the job he left; and if after a fair trial he fails to qualify for the new position, he will have to take whatever position may be open in his craft.

Rule No. 46

Applicants for employment *may* be required to *take physical examination at the expense of the carrier to determine the fitness of the applicant to reasonably perform the service required in his craft or class. They will also be required to make a statement showing address of relatives, necessary four years' experience, and name and local address of last employer.*

Rule No. 48

Employees injured while at work will not be required to make accident reports before they are given medical attention, but will make them as soon as practicable thereafter. Proper medical attention will be given at the earliest possible moment, and *when able,* employees shall be permitted to return to work without signing a release pending final settlement of the case.

At the option of the injured party, personal injury settlements may be handled *by the duly authorized representatives of the employee with the duly authorized representatives of the carrier.* Where death or permanent disability results from injury, the lawful heirs of the deceased may have the case handled as herein provided.

Rule No. 50

Existing conditions in regard to shop trains will be continued unless changed by mutual agreement, *or unless, after disagreement between the carrier and employees, the dispute is properly brought before the Labor Board and the Board finds the continuance of existing conditions unjust and unreasonable, and orders same discontinued or modified.*

The company will endeavor to keep shop trains on schedule time, properly heated and lighted, and in a safe, clean, and sanitary condition. This not to apply to temporary service provided in case of emergency.

Rule No. 55

Work of scrapping engines, boilers, tanks, and cars or other

Can the Foreman Manage Himself?

The foreman must deal tactfully yet firmly with the workers under him. To control others he must first know how to control himself.

How many good employees are lost to the service because the foreman could not control himself at a critical moment? Not only does he do an injustice to the worker but he loses the respect of the other men, often with an unhealthy reaction on production.

Is it not true that the success of a department depends to a large extent upon the personality of the foreman?

machinery will be done by crews under the direction of a mechanic.

Rule No. 60

At the close of each week one minute for each hour actually worked during the week will be allowed employees for checking in and out and making out service cards on their own time.

Rule No. 65

Machinists assigned to running repairs shall not be required to work on dead work at points where dead-work forces are maintained *except when there is not sufficient running repairs to keep them busy.*

Rule No. 77

At points where there are ordinarily 15 *or more engines tested and inspected each month,* and machinists are required to swear to federal reports covering such inspection, a machinist will be assigned to handle this work *in connection with other machinist's work* and will be allowed five cents per hour above the machinist's minimum rate at the point employed.

At points or on shifts where no inspector is assigned and machinists are required to inspect engines and swear to federal reports, they will be paid five cents per hour above the machinist's minimum rate at the point employed for the days on which such inspections are made.

Autogenous welders shall receive five cents per hour above the minimum rate paid mechanics at the point employed.

In each case the italic portion of the new rule is intended to eliminate the objectionable features of the old rule, especially those to which the railroads objected during the hearings on National Agreements.

Three Locomotive Shop Devices

BY E. A. MILLER

Too many precautions cannot be taken to guard against accidents to the eyes of workmen employed in railroad shops and roundhouses. When grinding work on an emery wheel or when truing up such a wheel with a dresser, the rules are very strict regarding the wearing of goggles to prevent flying particles of dust and emery from flying into the eyes of workmen or operators. The use of goggles will ordinarily be a sufficient safeguard but, as an additional precaution, the curved steel plate, 3½ in. wide, as shown in Fig. 1, is fastened by means of two 3/16 in. machine screws to the

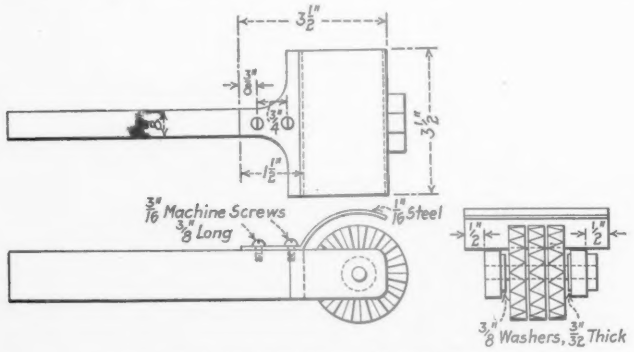


Fig. 1—Guard for Emery Wheel Dresser

emery wheel dresser. This plate is instrumental in deflecting most of the particles which fly from the emery wheel away from the man who is truing it up.

Drilling Grease Plug Holes

After the bushings have been pressed in side rods, it is necessary to drill holes for the grease plugs which serve two purposes, controlling the supply of grease to the bearings and preventing loose bushings from turning in the rods. The common method of drilling these holes is to place the rod under some type of drill press and drill down through the brass bushing with a drill somewhat smaller than the smallest diameter of the grease plug threads.

There are two objections to this method in that the drill damages the threads in the rods and usually drills a hole which is off center in the rod bushing. When the attempt is made to apply a grease plug, it is often found, therefore, that the threads are damaged to such an extent that the plug cannot be turned into the rod. Moreover, the cylindrical end of the grease plug will not enter the hole in the brass bushing on account of the latter's being off center and the usual procedure for the machinist or mechanic is to grind down the end of the grease plug until it will fit the hole in

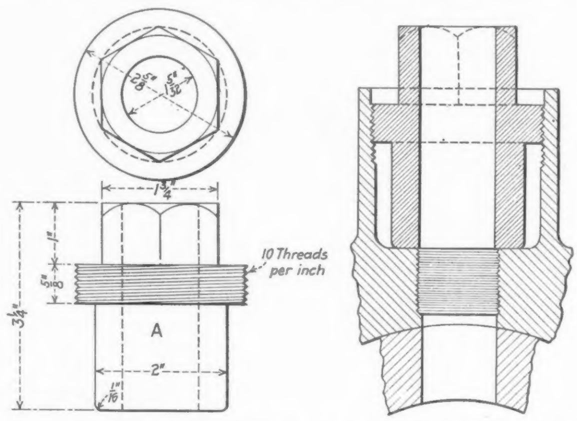


Fig. 2—Jig Used in Drilling Rod Bushing Grease Plug Holes

the bushing. This results in the diameter of the plug being considerably smaller than would otherwise be necessary and should the bushing become loose in service, quite a little play of the bushing in the rod may be expected.

To obviate these objectionable features, the arrangement shown in Fig. 2 has been devised. It consists of a steel jig *A*, drilled for a 1 5/32-in. hole and formed at one end in an hexagonal nut. A collar is threaded, as shown, to suit the internal threads in the side rod grease cup. In using this jig, it is turned into the grease cup until it strikes the bottom and guides the drill when drilling the hole in the side rod bushing. It is apparent that this jig will not only guide the drill and prevent damaging the grease plug thread, but the hole in the rod bushing will be centrally located and no difficulty will be experienced in applying the grease plug.

Cab Apron Holder

The hinged sheet-iron apron between a locomotive and tender is quite heavy and often difficult to handle in coupling

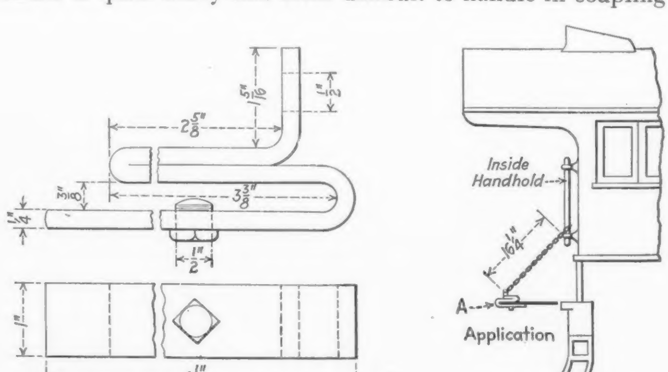


Fig. 3—View Showing Details and Application of Cab Apron Holder

or uncoupling the tender, requiring the services of a man to hold it up unless some other method is provided. Fig. 3 shows a simple device for holding the cab apron in a horizontal position while making the coupling, thus avoiding the need of holding the apron by hand with consequent danger of accident. During the time that the locomotive is in the shop, the device can also be used to hold the apron up out of the way of workmen.

The construction of the holder with set screw and supporting chain is readily apparent from the illustration.

Interesting Examples of Blacksmith Shop Work

Dies and Formers Used to Facilitate Work Under Heavy Steam Hammers; a Good Example of Gas Welding

BY WESLEY J. WIGGIN

Assistant Blacksmith Foreman, Boston & Maine, Billerica Shop, Mass.

THERE is opportunity for considerable saving both of time and money in blacksmith shop work, particularly by the use of carefully designed dies and formers in connection with steam hammers. In fact, by the use of suitable formers, it is possible to perform certain operations under the hammers in a small fraction of the time which would be required were such formers not available.

For example, Fig. 1 shows the details of formers used for offsetting end sills for standard motor trucks. The appearance of the straight sill and the former before offsetting is clearly shown in Fig. 2 and the finished sill in Fig. 3. The operation of the formers also is perhaps most clearly shown in these two illustrations from which it is evident that the base of the former rests on the anvil of a 2,000-lb. steam hammer with two forming blocks held at the proper distance apart by means of a $1\frac{1}{2}$ in. round bar, bent at right angles at the ends for insertion in corresponding holes in the respective forming blocks. The blow of the hammer is delivered to a top die block, provided with a handle, shown in detail in Fig. 1. This handle fits in the two holes shown in

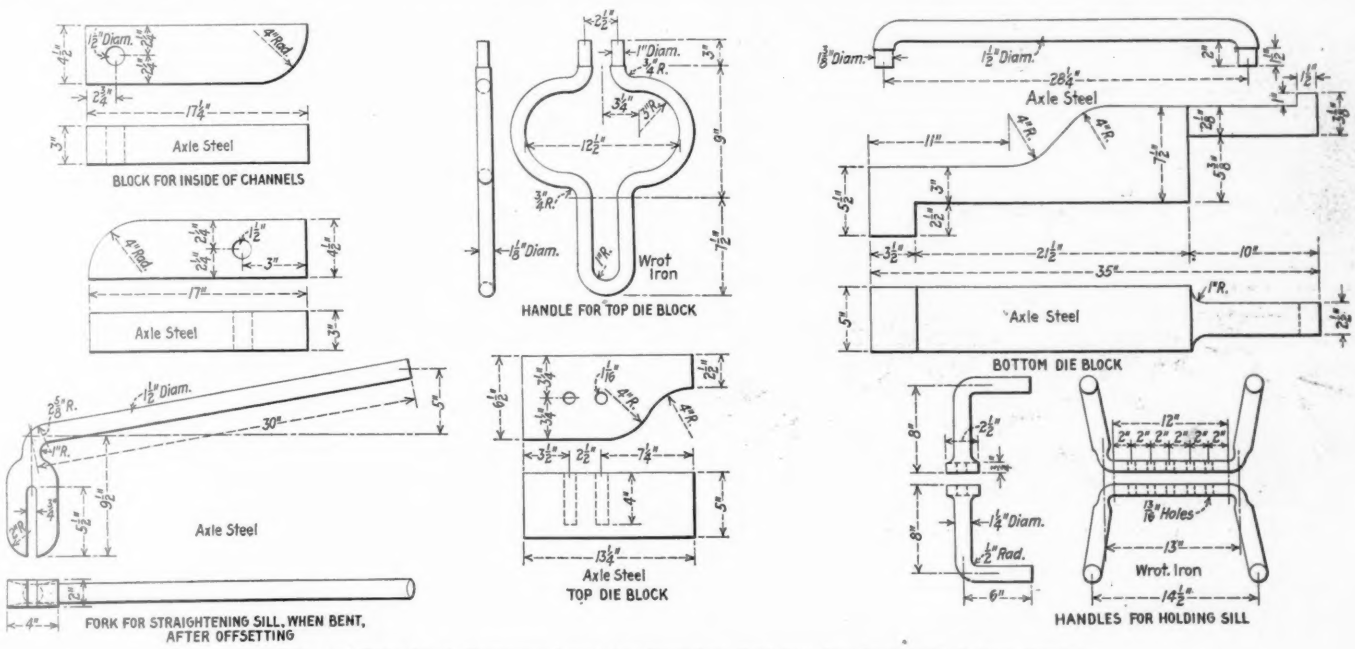


Fig. 1.—Details of Formers Used for Bending End Sill for Standard Motor Truck

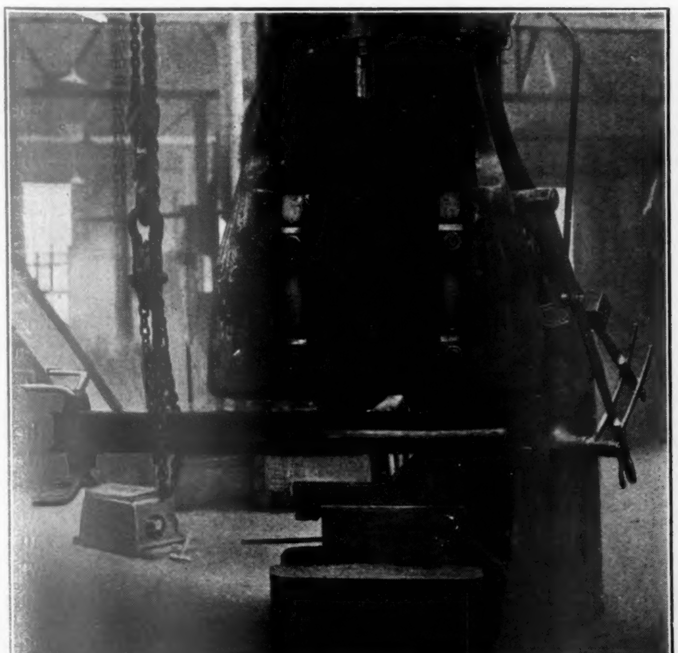


Fig. 2.—View Showing Formers in Place and End Sill Before Being Offset

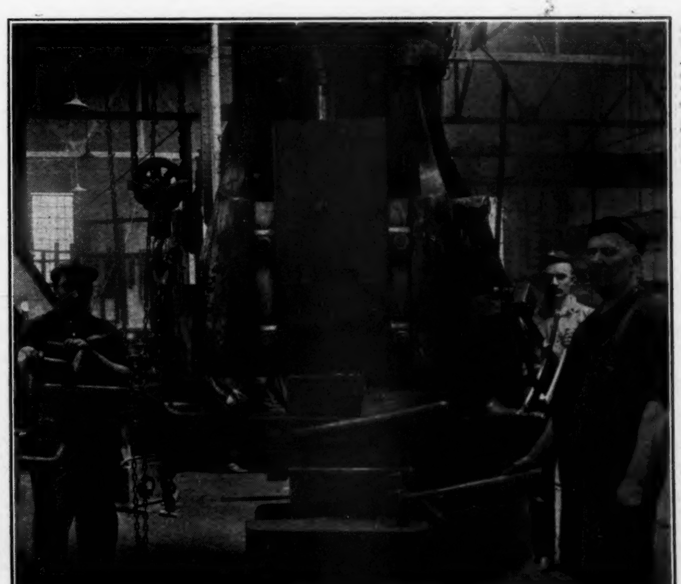


Fig. 3.—Formers and Sill After Being Offset

the top die block, the spring of the handle and friction being sufficient to hold the handle in place. A handle fork is provided for straightening the sill should it become bent after offsetting, although the dies perform the operation so accurately that this handle fork is not generally needed. Iron handles to facilitate holding and turning the sill are shown at the left in the illustrations, details being given in Fig. 1.

Reclaiming Bent I-Beams

When steel underframe cars become involved in wrecks it frequently happens that they are sent to the shop with the channels and I-beams going into the construction of the steel underframe badly bent. While these parts sometimes are damaged to such an extent that they cannot be reclaimed, most

Fig. 4.—Straightening a 10-In. I-Beam

of them can be straightened and used again provided hammersmiths, experienced and skillful in work of this character are available.

Two 10-in. I-beams, one of which has been subjected to unusually severe usage, are shown in Fig. 4 in the process of straightening. One is under the hammer practically completed and the other is on the floor. In straightening these steel underframe members, it is essential to work them no more than necessary, otherwise they will be lengthened and

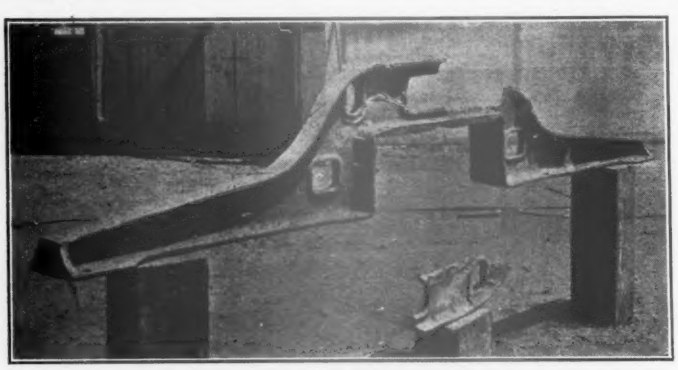


Fig. 5.—Broken Needle Beam of Commonwealth Steel Underframe

holes will not line up when the member is reapplied to the steel frame. A little working will not make much difference, but where the beam is heated and bent too many times, it will be found necessary to relocate and drill bracket and other holes.

Welding a Needle Beam

The repair of the broken needle beam of a Commonwealth steel underframe is illustrated in Figs. 5 and 6. It will be observed from Fig. 5 that a section of the needle beam was broken out due to the wreck of the coach containing this steel underframe. The broken part was successfully rewelded in place as shown, the repaired needle beam then being as good as new.

It is important in work of this kind where the repaired parts are subject to vibration and severe stress that experienced welders only be used. While the judicious use of the welding torch will save many thousands of dollars, it is

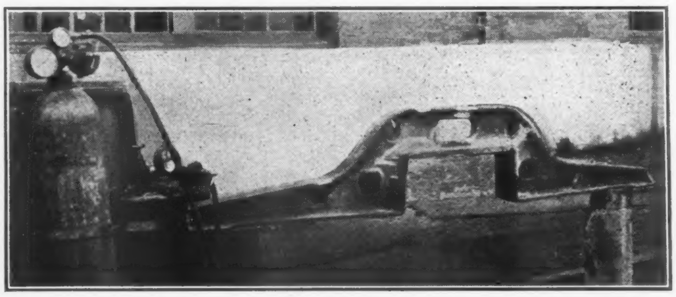


Fig. 6.—Needle Beam, Shown in Fig. 5, As Repaired by Gas Welding

equally true that much discredit has been brought to the use of autogenous welding processes due to inexperienced operators who fail to appreciate the limitations of the torch and use it indiscriminately and without the employment of good judgment. In all welding not only should the welds be carefully made, but internal stress in the parts due to contraction after cooling should be relieved. This can be accomplished easily in most cases by slowly heating the opposite members with the torch and allowing them to contract equally, or in some cases, however, it may be necessary to heat the entire part to a dull red heat and allow it to cool slowly to atmospheric temperature.

Repairing Tube-Sheet Cracks in Locomotive Boilers*

The firebox tube-sheets of locomotive boilers sometimes develop cracks between the tubes, and the question of repairing these cracks is a matter of interest. Frequently the work of repairing tube-sheets falls to the engine terminal staff, as at the time the cracks develop, the locomotive may not have run the necessary miles to warrant a shopping for general repairs. Often it is found possible, when a locomotive is sent into the shops, to repair a cracked tube-plate rather than renew it.

The method of repair depends upon whether or not the boiler is empty of tubes. If only a few tubes in the vicinity of the cracks are removed a good repair can be made by threading the tube holes which have their bridges cracked and inserting tapered brass plugs. Heads are formed on the plugs which meet one another and entirely cover the cracks. The centers of the plugs are then drilled to receive the tubes, the tubes in this case being smaller than the original to allow of a substantial thickness of metal in the bushing. This method makes a fairly good repair as the tubes have an unbroken contact surface and the cracks are covered and protected by the heads of the plugs.

Another method often employed is to insert plugs as in the previous case, and then bore a tube hole into every alternate plug, leaving the remainder solid and plugging up the corresponding holes in the smokebox tube-plate. The tube-plate is thereby strengthened in the parts which are cracked, but the heating surface is reduced and additional stress thrown on stays which may be in the vicinity.

* Abstract of an article in the August 12, 1921, issue of Engineering, describing a method of repairing cracks in copper tube sheets, but which should be equally applicable with steel tube sheets.

Gas Machine Cutting in Railroad Shops

A Discussion and Illustration of the Uses of the Radiagraph —a Mechanically-Operated Torch for Cutting Sheet Metal

CUTTING with oxy-acetylene hand torches in locomotive and car shops has become so general and presents so many advantages that railway shop men will naturally be interested in some of the applications of mechanically-operated cutting torches, of which the Radiagraph is an example. Machines of this type have already been installed in certain railroad shops and afforded in some cases remarkable opportunities for time and labor saving. While all of the illustrations given in this article are not taken directly from railroad shop practice, the operation in each case is similar to many which have to be performed daily in locomotive and car repair shops.

Fig. 1—Trimming a Steel Plate with the Radiagraph

Straight Line Cutting

Referring to Fig. 1 it will be evident that the Radiagraph is being used for straight line cutting in trimming the steel plate illustrated. There is a large amount of this work to be done in railroad shops not only in the boiler department but especially in shops equipped to handle steel car repairs. It will be noted that the Radiagraph, which is a machine weighing about 50 lb., operates on a light, weight grooved track, made in sections five feet long. When cutting straight lines two sections of the grooved track are required for long cuts, one section being taken up after the machine has passed over it and placed ahead of the section then in use. This process is repeated indefinitely depending on the length of the cut.

Fig. 2—Cutting to a Circle in ½-In. Steel Plate

The cutting torch is held in a double swivel at the end of a radial arm adjustable vertically and laterally. A triangular frame work carrying the torch and driving gear is supported by three wheels, one at each corner, thus making a carriage. Two of the wheels are used for traction on straight line cutting, being driven through gearing by a 1/20-hp. electric motor. A gear-box interposed provides for 20 speed changes, the speed used depending upon the thickness of the metal to be cut and the required smoothness of the cut. Ample power for the electric motor is provided from any light socket and the motor is set in motion by the act of opening the valve controlling the oxygen cutting jet, a switch being mounted on the end of this valve. The machine is started when the metal has been heated to the cutting temperature and the oxygen jet is turned on.

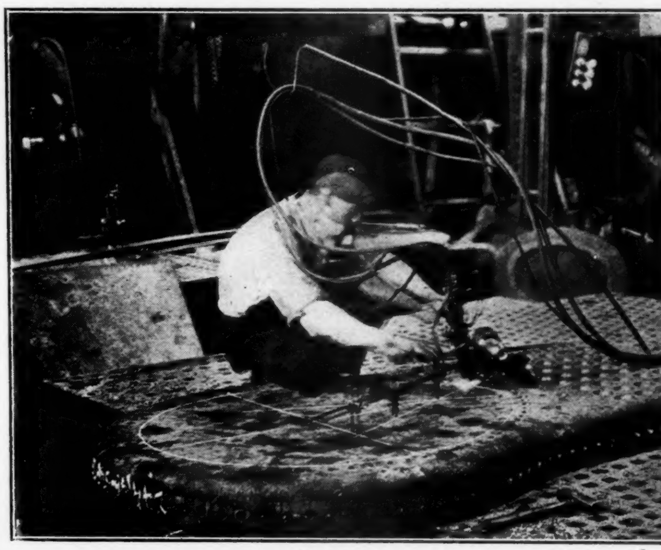


Fig. 3—In Cutting an Oval Opening, the Machine Swings on Three Different Radial Lengths Successively

A peculiar advantage of the above arrangement is that the torch can be adjusted sideways to any desired angle in the swivel holder, thus producing a beveled edge. Trimming and beveling are therefore done at one and the same time.

Cutting to a Circle or Oval

The illustration given in Fig. 2 shows the use of the Radiagraph in cutting a circle in a ½-in. steel plate. There are many occasions in railroad shop work when it would be an advantage to have means for quickly and accurately cutting circles in steel plates. The Radiagraph is adapted for this purpose by disengaging one of the two tractor wheels, the drive then being affected by one tractor wheel only and the entire machine swivelling about an adjustable center point resting in a prick punch mark at the center of the circle. It is important to note that the speed of the cutting torch can be reduced to a point giving the required smoothness of cut so that additional machining will be unnecessary. This elimina-

tion of additional machining is a valuable feature of the Radiagraph and one which enables it to affect large savings in production cost.

The circular cutting, illustrated in Fig. 2 may be varied to produce elliptical or oval shaped, or cutting a combination of arcs and straight lines. When cutting the oval opening in a combustion chamber head, Fig. 3, the operator manipulated the adjustable center points successively, thus changing the effective length of the radius bar, without stopping the cut. In this case the machine swung on three different radial lengths successively. While it is not probable that much elliptical cutting will be found in railroad shops, the flexibility of the Radiagraph is plainly shown by its ability to handle this operation and should the occasion arise to cut an elliptical hole in sheet iron the use of the machine will reduce the cost.

Particular attention is called, in Fig. 3, to the method of suspending the two lengths of acetylene and oxygen hose and the electric extension cord from a support over the center of the table. This enables the Radiagraph to work without interference from the hose and cord.

Locomotive Frame Cutting

The use of the Radiagraph in cutting openings in small electric locomotive side frames for the axle boxes is plainly shown in Fig. 4. While work of this exact nature will not be encountered in railroad shops, the illustration is given on account of its general interest and to indicate the possibility of the Radiagraph in cutting thick metal. In this particular case the locomotive frames are made from steel slabs, 3½ in. thick, by cutting out the axle box openings. On short cuts like this, one section of track only is used. An ordinary cutting speed for low carbon steel, 3½ in. thick, is from 8 to 12 in. per min. but in this case the cutting was required to be done with such precision and smoothness that no machining afterwards would be needed and the feed rate, therefore, was reduced to three or four inches per minute. The resultant cuts are smooth, being comparable to a slotter cut made with fine feed and a pointed tool.

The practice in cutting the frames illustrated is to lay out and drill all holes including starting holes at the corners of the openings and all cuts are made tangent to the drilled holes so that a true radius is left in the corners. The material removed by cutting is salvaged, being used in the forge shop and elsewhere for parts that can be worked up from the material available.

In ordinary locomotive repair shop practice, the Radiagraph can be successfully used in working up ashpan sheets and doors, boiler mud rings, flue sheets, crown sheets, back heads, door frames, running boards, steps, reinforcing rings, cab doors, connecting rods, eccentric rods, equalizers, levers, links, pipe flanges, etc. In car shop work, side sheets, end sheets, hopper bottoms, hopper doors, brake levers and hangers constitute a few of the steel car components that may be advantageously machine cut with oxygen. A feature of the portable oxygen-cutting machine, very important in car shops and yards, is the saving of transportation to machine tools which must necessarily be located at points convenient to the whole area served. If, however, a lightweight gas-cutting machine is taken to the work, time and labor are saved and often mistakes avoided due to misunderstanding of layouts.

Inclining the Torch When Cutting

Straightaway cutting with the hand torch is facilitated by inclining the head of the torch backward after the cut is well started. The degree of inclination will vary somewhat with the thickness of the metal and other conditions. A fairly conservative figure is 65 to 75 deg. angle from the plate behind the torch to the torch head. The effect of inclining the torch is to speed up cutting considerably. The gases directed at an angle preheat the thin edge of undercut metal ahead of the igniting temperature more rapidly than when the tip is held squarely with the plate. The gases and products of combustion turn backward, passing through an arc of, say, approximately 90 deg. and shooting down and back. Often the drag or lag of the cut will be as much as one-half or even three-quarters inch on half-inch steel. When cutting with the torch inclined, it should be uprighted just before finishing the cut in order to sever the metal at the end. Otherwise a wedge of uncut metal will be left due to the oxygen shooting by the corner as the torch reaches the end of the cut. The "drag" part of the cut will be left untouched. Uprighting of the torch cuts this portion off cleanly.

Expert hand cutters are able to cut one-half-inch steel plate with a very narrow kerf and low oxygen pressure, often working at speeds up to 24 in. per min. and sometimes faster. The experienced cutter learns to follow the cut with great precision, going no faster than permissible, but still following the combustion rate so closely that there is little or no loss of cutting efficiency. The cutter who tries to work too fast "loses the cut" and makes a mess of things. The cutter who works too slow wastes gas and time, while the one who knows just how fast to cut approximates 100 per cent efficiency in time and gas.—*Autogenous Welding.*

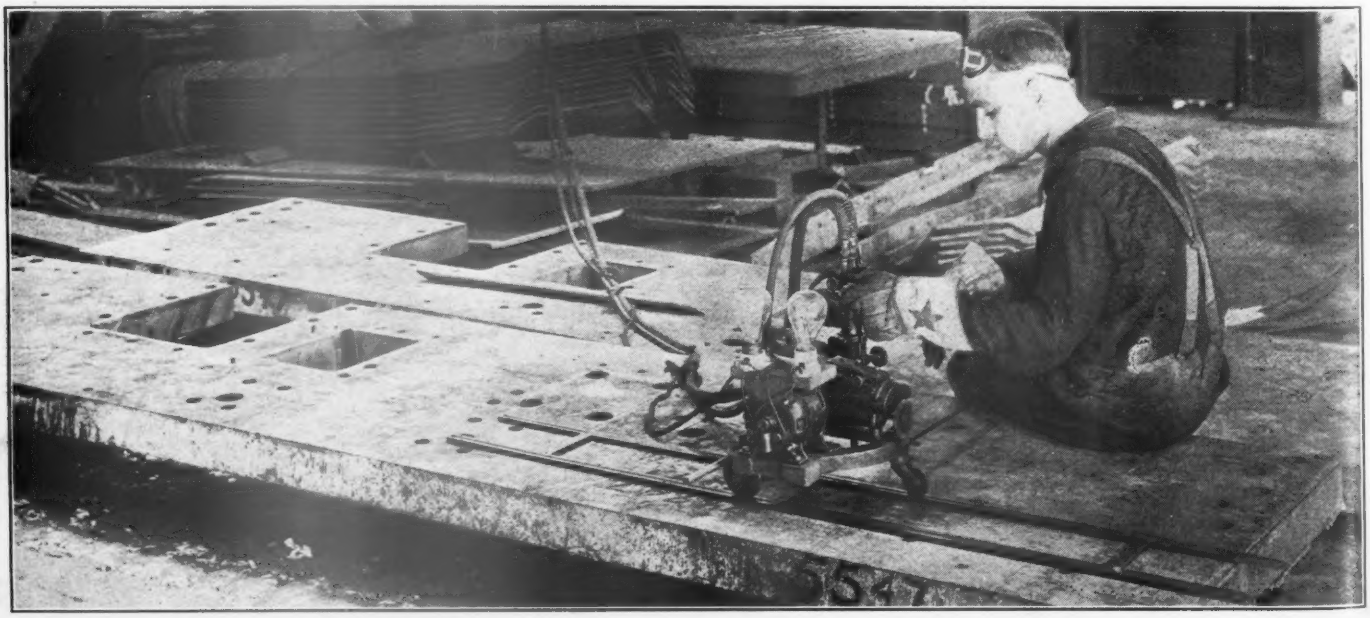


Fig. 4—Cutting 3½-In. Steel Slabs for Small Electric Locomotive

Construction and Maintenance of Cinder Pits

Report of American Railway Bridge and Building Association Committee Discusses Three Types

CINDER pits may be divided into the following types: (A) Depressed track pits where ashes are loaded into cars by hand. (B) Dry pits where ashes are received in cast iron buckets and loaded into cars by means of an overhead crane. (C) Water pits, both shallow and deep, where ashes are removed by clamshells operated by a locomotive or overhead crane and loaded into cars. (D) Miscellaneous pits, where ashes are removed by various mechanical means.

Fig. 1 shows a standard pit used by the Duluth, Missabe & Northern at Proctor, Minn., which is typical of the handloading pits installed by many of the railroads in this country. The pit is constructed with one rail resting on the back wall of concrete, and the other on two 10-in. channels back to back with cover plate top and bottom, the channels being supported by cast iron pedestals on 7-ft. centers. This pit has failed in one respect: The action of the hot cinders and water on the top and face of the back wall have caused it to crumble and produce an unsafe bearing for the rail. No trouble has been experienced with the cast iron pedestals, and with a reasonable amount of cleaning of the hot cinders away from the steel beams, they do not buckle. The beams require cleaning and painting every spring and fall. The back wall can be protected with old plates ¼-in. thick hung over the edge of the back wall on the inside of the pit and down the pit about 3 ft., leaving an air space between the cinders and the concrete. This will prolong the life of the back wall.

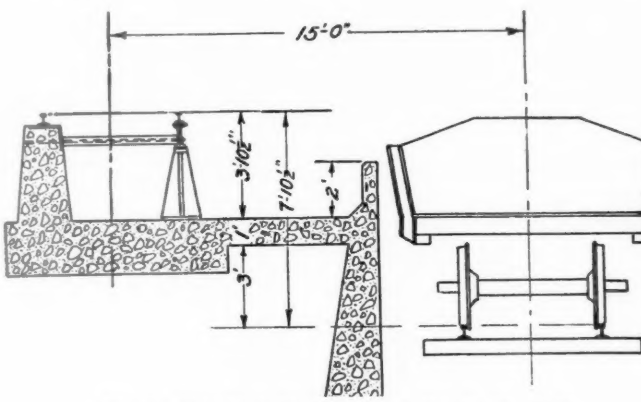


Fig. 1—Standard Cinder Pit of the D. M. & N.

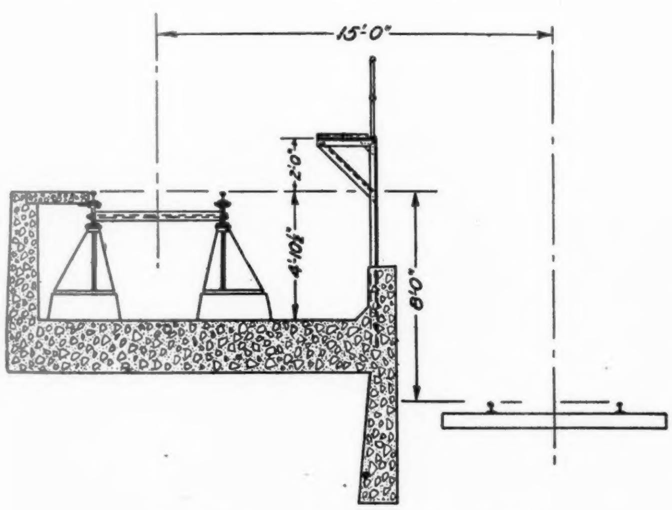


Fig. 2—A Second Design of Type A Pit

Fig. 2 shows the pit deepened and both rails supported on cast iron pedestals with a pre-cast slab between the rail and back wall; this design keeps the rail off the concrete wall and leaves the beams and pedestals exposed where they can be replaced in a few minutes if a failure should occur.

Fig. 3 shows a dry pit used by the Bangor & Aroostook, and is similar in construction to Fig. 1, the difference being that the bottom of the pit slopes from the back wall to the center of the pit; the beam carrying the track is made of two 70-lb. rails placed upside down to support the track; the pedestals are spaced 6 ft. ⅜ in. between centers and are built of two 70-lb. rails back to back on end and encased in concrete, the concrete being protected by a ⅛-in. steel plate; these vertical rails are supported by two 70-lb. rails running lengthwise in the foundation.

The Buffalo, Rochester & Pittsburgh has built a pit of Type B at Lincoln Park, N. Y., shown in Fig. 4, which seems to be a favorite design for a dry pit in cold climates.

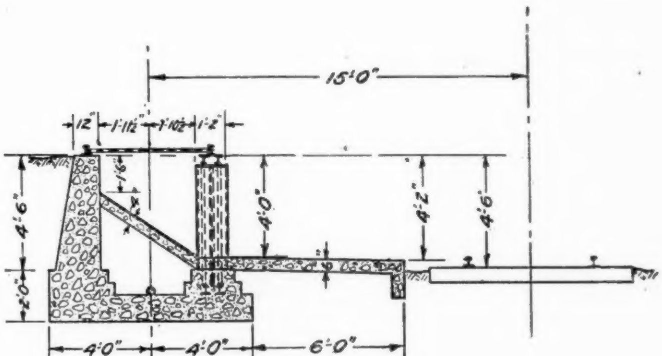


Fig. 3—A Dry Pit Built by the Bangor & Aroostook

This pit can be built with one track and a loading track, or if the length of the pit is fixed, several tracks can be built side by side. This style of pit is constructed of a series of cast steel buckets placed in shallow pits to receive ashes direct from locomotives. There is enough depth provided under the buckets to allow for drainage. The buckets are handled by means of an overhead crane from the pit directly to the ash cars. The pits are of an unusual shape with sloping sides in the upper part and a narrow rectangular lower portion, old rails being imbedded in the sloping surfaces with their bases projecting ⅛ in. from the surface of the concrete; each parapet wall is capped with a 12-in. channel to which the track rail is bolted. The buckets have a capacity of 2 cu. yd. each, each seated on the projecting rails of the pit walls. When the buckets are filled the traveling crane carries them to the cinder cars where they are dumped automatically. The buckets open at the bottom like a clam shell, the two halves being carried by a pair of scissor levers at the middle.

The Lehigh Valley has two modern water ash pits of Type C, both being built within the last three years. The one at Coxton, Pa., Fig. 5, is a double-track arrangement, 400 ft. long with a water pit between the two tracks. The water pit is 12 ft. wide in the clear by 14 ft. 3 in. deep, the ash tracks having 29-ft. centers. The water in the pit is generally within 1 in. of the bottom of the carrying rails, so that it is impossible to overheat or burn any part of the

supporting structure. The outside rail of each ashing track is carried on the outside concrete wall of the pit, bearing on a ½-in. iron plate. The inside rail of the ashing track is carried by three rail girders supported by heavy cast iron posts with large bases imbedded in the concrete. These carrying girders consist of two 136-lb. rails, side by side, with spacing blocks so designed that the base of the track rail, also of 136-lb. section, rest on and are gripped between these spacing blocks and the heads of the two lower carrying rails, forming, when tightly bolted together, a rigid girder.

The walks around the ashing tracks of this pit consist,

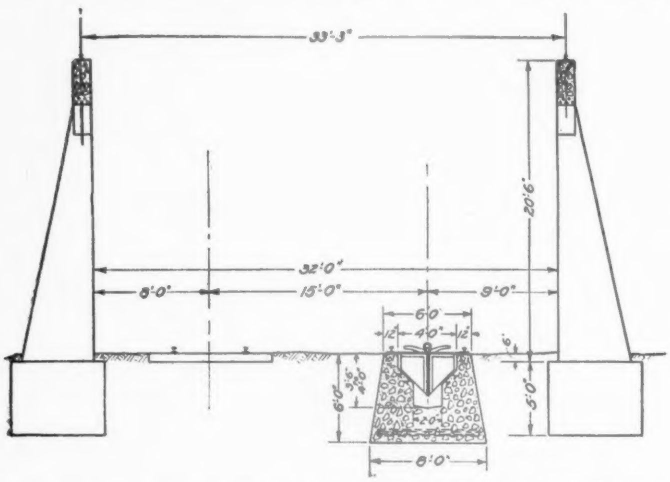


Fig. 4—Type B, Pit Built by the Buffalo, Rochester & Pittsburgh at Lincoln Park, N. Y.

on the outside, of the natural surface of a cinder fill, while on the inside the walk consists of 80-lb. rail brackets fastened to the cast iron columns. The rail brackets carry the floor of the walk, consisting of old boiler flues laid side by side and spaced by means of iron straps, so that the finer ashes fall through. A suitable railing, also of old flues, amply protects anyone from falling into the water pit.

Crushed slag was used in the concrete for the pit as a precaution against hot cinders coming in contact with the concrete while the pit is without water.

The Pere Marquette installed a mechanically-operated pit

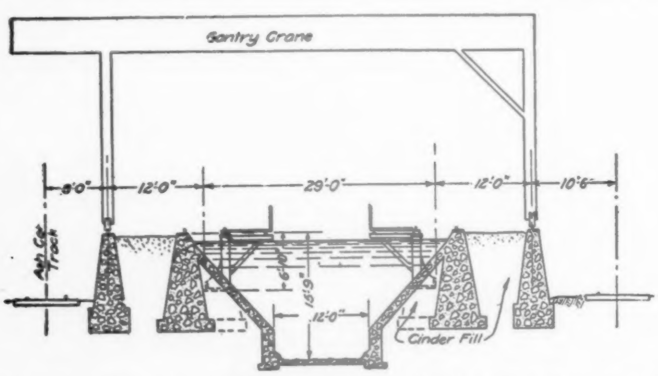


Fig. 5.—Type C, Water Pit Built by the Lehigh Valley at Coxton, Pa.

in January, 1912, which seems to be a favorite for small terminals and shows a low cost of operation. From recent reports the pit and conveyor are in good shape with very little maintenance. There are two good points in favor of the mechanically-operated pit. It requires less room, due to cinders being loaded continually into cars; and it requires but one man to operate it, which makes for a low operating cost. The structural steel in these pits should be inspected, cleaned and painted frequently.

The report was signed by G. K. Nuss (D. M. & N.), chairman; C. L. Beeler (N. Y., N. H. & H.), Wm. Cardwell (Wash. Term.), H. A. Gerst (G. N.), W. L. Rohbock (W. & L. E.), F. E. Schall (L. V.), E. R. Wenner (L. V.), J. P. Wood (P. M.), A. E. Kemp (L. V.).

Discussion

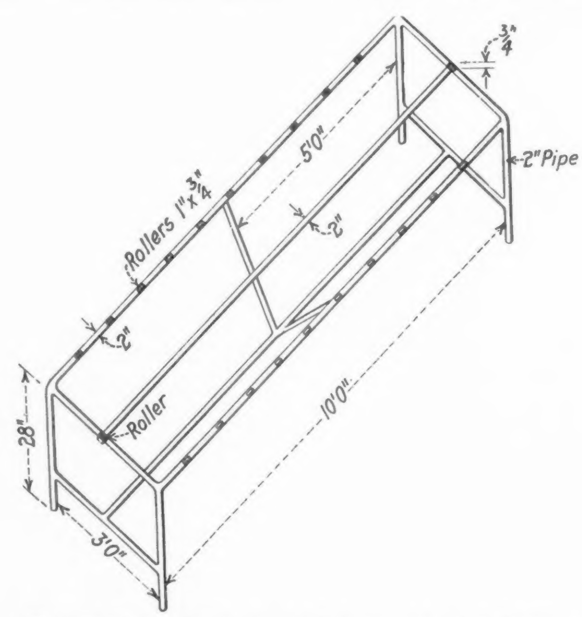
The discussion hinged largely on the efficient use of the ash pits in connection with the equipment and the disposal of the cinders. It was emphasized by Arthur Ridgeway (D. & R. G. W.) that no car had as yet been developed that would handle hot cinders without resulting in the destruction of the car body by burning or warping. Quenching was necessary though it gave considerable trouble in the winter with the handling of the cinders. It was stated by J. S. Robinson (C. & N. W.) that at the Chicago terminal the cinders are loaded into out-bound empty coal cars, moved to West Chicago, and there unloaded by locomotive cranes and stored. Later they are loaded as needed, and distributed to branch lines for ballast and to other places where they can be used to advantage. Other members stated that their roads make a practice of storing cinders in the winter to obviate the difficulty of handling them when frozen. L. D. Hadwin (C. M. & St. Paul) stated that one difficulty arose from the fact that the use of locomotive cranes to handle cinders has the disadvantage in that it may be taken away and used out on the line with the result that the cinders pile up in quantity, and in the winter time freeze.

Table for Oxy-Acetylene Cutting

BY J. J. ALBERT

Repair Track Foreman, Michigan Central, Kensington, Ill.

An effective form of table for holding sheet metals while being cut with a torch is shown in the illustration, the idea being to have the plates brought to the operator on rollers with no undue exertion on his part and enabling him to stand in one place. The table is built of two-inch pipe, twenty-two—1-in. by ¾-in. rollers being used to carry the work to the operator. These rollers extend ½ in. above the



Cutting Table Built Up of Rollers and Pipe Sections

surface of the table, being applied on pins cut and welded into the pipe. This arrangement leaves the rollers free to revolve and by having the table center brace ½ in. below the surface of the table the material will not drag if it sags down but will bear on the rollers only. The value of this table as described lies in the fact that it can be quickly and cheaply constructed, at the same time assisting materially in the work of oxy-acetylene operators when cutting all kinds of sheet metal.

The Metallurgy of High Speed Steel*

A Brief Outline of the Development, Characteristics and Method of Manufacturing High Speed Steel

BY D. M. GILTINAN

DEVELOPMENT of high speed steel as distinguished from carbon tool steel has been a matter of the last 50 years. The development of the present day cutting alloys in this short space of time, as compared with the hundreds of years previous in which there was no development, calls for some explanation. This explanation lies in the fact that the manufacturing industries of the civilized world have, during the same period, demanded a means for securing increased production without the increase in cost which would accompany additional buildings and equipment. The alternative was to speed up each individual machine, and in attempting to do so it at once became apparent that the tool steel then in use would not meet the requirements of increased speed. These requirements were:

1. The tool must possess initial hardness greater than the material cut, and also must be sufficiently hard to resist wear.

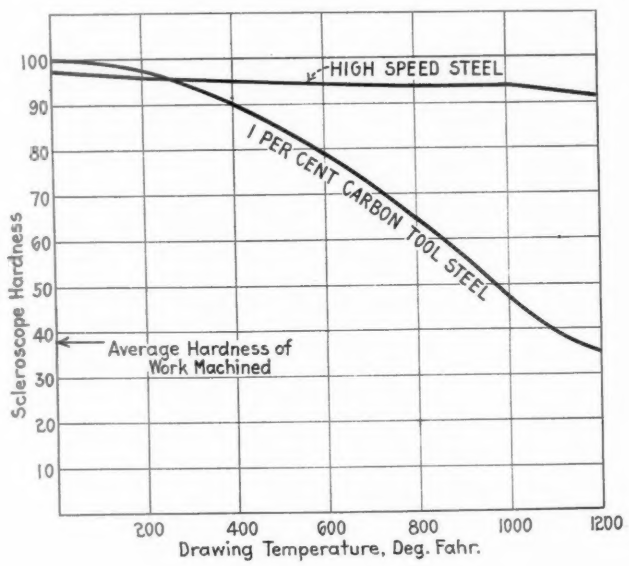


Fig. 1—Effect of Heat on Hardened Steel

2. The tool must not soften when subjected to the heat developed through friction, due to increased relative speed of the tool and the work.

Tool steel, in the generally accepted sense of the word, is an iron-carbon alloy containing from 0.6 to 2.0 per cent carbon with an average of approximately 1.0 per cent carbon. The carbon exists as iron carbide, or cementite, Fe_3C, which is extremely hard and above 1,350 deg. F. the stable condition of the alloy is a solid solution of Fe_3C in the iron or ferrite. Below 1,350 degrees F. the Fe_3C separates out of the solid solution and the stable condition is a mixture of Fe and Fe_3C, which is comparatively soft, due to the cementite being isolated in globules or plates in the soft ground mass of ferrite. If the solid solution is cooled rapidly the carbide is held in solution, resulting in uniform hardness throughout; but the alloy is in a meta-stable condition and will revert readily to the stable upon application of heat. This softening commences at about 300 deg. F. and at 1300 deg. F., or dull red, has become very soft as illustrated in Fig. 1.

Present high speed steels, on the other hand, when properly hardened are initially hard, and moreover there is only a small decrease in hardness when heated to a dull red; that is, high speed tools are as hard when operating at speeds where friction is sufficient to make the tools red hot as are carbon steels, when operating under conditions of very light cut and feed and low speed.

Development of Modern High Speed Steel

The development of modern high speed steel started about 1866, when Robert Mushet of Sheffield discovered the value of manganese as an alloying element of bessemer steel, giving added ease of fabrication. In the course of further experimental work with manganese on tool steels he noted that one particular composition possessed the property of hardening when cooled in air. This was distinctly out of accord with the knowledge of steel hardening at that time, and careful analysis developed the fact that there was considerable tungsten present in addition to the manganese. The combination of tungsten and manganese in conjunction with high carbon resulted in lowering to below room temperature the point where the carbide separated out of the solid solution, giving the property of "air hardening," a term which was at once applied as a trade name to this particular steel.

F. W. Taylor in 1900 discovered the great increase in cutting speed made possible by heating tools practically to melting point when hardening. This was a revolutionary step, as it had always been known that heating a carbon steel any higher than necessary to produce uniform solution of the carbide resulted in a coarsening of the crystallization and accompanying brittleness when hardening. In fact, a carbon tool steel heated as high as 2300 deg. F. would be absolutely ruined. Further work at Bethlehem showed the advantage of higher chromium content, and between 1902 and 1906 there was in Europe and America a movement which resulted in the adoption of carbon content now generally in use (0.60 to 0.80 per cent) and increasing the amounts of chromium and tungsten up to the maximum of 7 per cent chorium and 24 per cent tungsten. It was found, however, that the maximum efficiency was obtained with a chromium content of 3 to 4 per cent and 18 per cent tungsten. Molybdenum was also tried in place of tungsten, or to replace it partially, but it was found that while molybdenum produced an excellent high speed steel, it was rather uncertain and caused seams and hardening cracks so that its use was discontinued.

About the same time vanadium was added in this country, and, while it was found that it improved the cutting capacity, it was thought, erroneously as it later turned out, that the increase obtained did not compensate for the additional cost entailed. In 1908-1909, Europe and America brought out simultaneously a high tungsten steel containing approximately 1 per cent vanadium which met with immediate success, and since that time vanadium has been an essential component of practically all high speed steels. Its action has never been understood fully, and there have been few attempts to explain its effect, which is to increase the life of the tool when working at high temperatures.

Methods of Manufacture

The manufacture of high speed steel involves no different processes than those by which all high grade cutting steels

*From a paper presented before the Charleston chapter of the American Society for Steel Treating. The author, D. M. Giltinan, is associated with the micro laboratory, Bureau of Research, United States Naval Ordnance Plant, Charleston, W. Va.

have made for the past hundred years, although, of course, like all other manufacturing processes, certain refinements and minor improvements are made from time to time. At the present time in this country, most high speed steel is made by the crucible process, although the electric furnace method is gaining in favor, due to the ability of the latter to refine low grade material. In the crucible process a predetermined amount of high speed steel scrap, low carbon bar iron, ferrochrome, ferrovanadium and either tungsten powder or ferrotungsten are packed in crucibles and sealed with sand or clay. Each pot holds about 100 lb., and about 30 to 35 pots are put in the furnace at one time, melted and thoroughly mixed after melting by pouring into the ladle, from which the ingots are cast. As soon as the metal in the ingots is solidified the mold is stripped and ingots are cooled very slowly, either in ashes or in a soaking pit. Extreme precautions must be taken, as high speed is very sensitive to rapid temperature changes and would crack if allowed to cool suddenly.

The ingots are then annealed to remove any strains set up in casting, and are carefully heated for fabrication. The ingots may be either rolled or hammered to bars after which the latter are reannealed and are ready for shipment. It is customary to ship bars annealed in order that any machine work may be done on them.

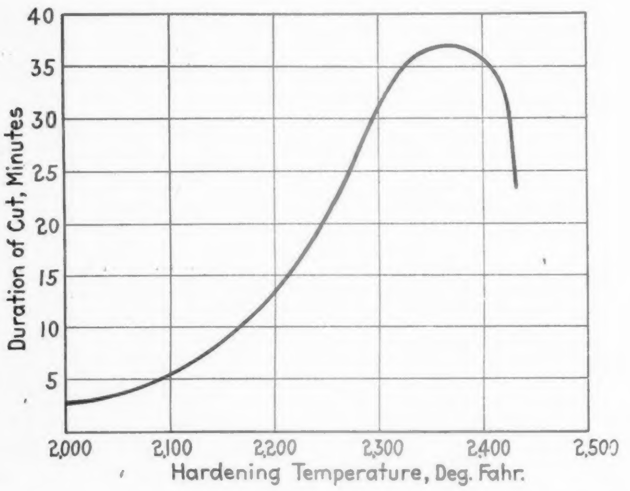


Fig. 2—Effect of Hardening Temperature on Cutting Capacity of High Speed Steel

Microscopic examination at high magnifications (500-1,000 diameters) shows that high speed steel in the annealed state consists of a matrix of what is probably the solid solution of iron and tungsten, which is studded with innumerable globules or "ponds," identified as carbides or tungstides of iron and chromium or a combination of both.

Upon quenching this steel from ordinary temperatures, that is, 1,400-1,700 deg. F., there is practically no change in structure and there is only partial hardening, showing that solution of the carbide is necessary for hardness. Tools hardened from these temperatures do not realize the possibilities in any way. It is only by heating to at least 2,250 or 2,300 deg. F., that the carbide may be brought into solution and it is then only that the full possibilities as a cutter tool are obtained. The effect of hardening temperature on cutting capacity is shown in Fig. 2. There is, of course, an extreme in high temperature, and if this is passed, more injury than good results. The steel is partially melted and an intergranular eutectic, which is extremely brittle, is formed upon cooling. This eutectic structure cannot be broken up by annealing and is always a source of trouble.

Red hardness is due to the conversion upon heating of the austenitic structure to martensite, which theoretically increases the hardness and which many investigators have found to be the case. Personally, the author has not found an increase, but has found that the hardness remained practically constant. In view of the extreme sluggishness with which the carbide goes into solution upon heating, it is natural to suppose that it will separate out of solution just as sluggishly upon reheating, thus accounting for the long time a high speed tool will run at red heat before failure.

Important Part Played by High Speed Steel

The practical importance of high speed steel is shown by comparing the manufacturing establishments of today with similar plants 20 years ago. The development of the present rate of production has been the result of a contest between the steel manufacturer and the machine tool manufacturer, with the producer as an interested spectator. The supremacy has alternated between the two contestants: first, one having a tool steel capable of higher speed than the machine would stand, and the other retaliating by building a machine of ample strength and free from vibration which would withstand a speed capable of burning up the tool. At the present time, the manufacturers of machine tools lead, and the next advance must be made by the steel manufacturer. Personally, the author believes that a cutting alloy whose hardness is not dependent on carbon and which is unaffected by heat is the coming high speed tool. The realm of alloys has yet only been touched since the number of alloying elements available and the possible combinations will give an infinite number of resulting compositions out of which can be found, one alloy or range of alloys which will have the toughness and keenness of steel and the heat-resisting qualities, or red hardness, of the present day nonferrous alloys.

Boiler Makers' Committee Reports Released

Reports on the Welding of Safe Ends and the Cause of Boiler Shell Cracking Through Rivet Holes Are Given

OWING to conditions over which it had no control, the Master Boiler Makers' Association cancelled the convention scheduled to be held in St. Louis, May 23-26, 1921, and the Executive Committee authorized the publication of reports of committees on subjects prepared and filed for that occasion, with the idea that members would thus be able to study the reports and be prepared to discuss them more fully at the convention. It was also hoped that members would offer suggestions enabling the respective chairmen to revise or amplify their reports for the 1922 convention provided it seemed advisable. The following two committee reports are presented in full by permission of the Master Boiler Makers' Association.

Methods of Welding Safe Ends on Locomotive Boiler Tubes

In submitting a report on the above subject, and as chairman of this committee, in making a composite report, I have therein embodied the substance of individual reports by the other committeemen, as well as information gathered by the chairman during the year in visiting large railroad shops throughout the country and in past personal experiences.

Standard Safe End Practice

We will first take up the welding of safe ends in the regular way which is in vogue in most of the large railroad shops; *viz.:* the oil furnace, roller and hammer welders. It seems to be the consensus of opinion of the committee that no difficulty is experienced in welding iron to iron, steel to steel, iron to steel, or vice versa. In this connection I wish to say, however, that where steel is being welded to iron, it is good practice to give the iron somewhat of a lead in the heat, as steel will weld very readily up from 2500 deg. to 2600 deg. F., and iron fuses nicely at about 2800 deg. to 3000 deg. This can be very readily done when heating the tube and opening it to receive the safe end; then return to the furnace immediately and it will have about the required lead in heat over the steel. If the tube should be placed in the fire with both iron and steel cold, I believe it to be good practice to set the material in the furnace so as to give the iron the benefit of the heat. With this practice there should be no trouble in welding steel to iron, or vice versa.

The committee seems to be somewhat divided on the scarfing of safe ends. A large number of shops are welding safe ends to tubes without scarfing, with very good results. The committee, however, recommends that the sharp burr be taken off the outer edge of the safe end before inserting it into tube; otherwise when being rolled down in welding the sharp edge cuts in and thereby weakens the wall of the tube, causing the tube in some cases to break off. It is my opinion that the scarfed safe end makes the smoother weld, providing the scarf is properly made; about ½ inch in length and at the thinnest end to be not less than 1/16 inch thick, instead of scarfing them down, as we find in a good many cases, to a feather edge.

It is the further opinion of the committee that it is not necessary to use flux in welding, the reason being that in a good many cases dirt and foreign matter become mixed with the flux, and when it is applied to the metal prevents cohesion, and the result is a defective weld. If the flux can be kept perfectly clean there seems to be no objection to its use. A very fine sand is being used in some places, and it is claimed with very good results. If, however, the welding qualities of the material are right, and the furnace constructed so that it will properly heat the material, there should be no trouble in welding without the flux.

Causes for Poor Welds on Safe Ends

Investigating complaints of trouble experienced in the welding of safe ends, we find that this can be attributed mostly to one or two things, or both—improper construction of the furnace and the roller welding machine not being speeded up to the revolutions necessary to make a quick and sound weld. The roller welding machine should have a speed of not less than 450 revolutions at the fly wheel. The material being of a light wall, it cools very rapidly, and therefore must have quick action for fusing. In our opinion, some of the trouble complained of is due to the oil burners being set so that they play directly upon the material to be heated; especially is this a fact in short furnaces. Where the oil is of a good grade and light, there seems to be no trouble in properly heating the material, but when the oil is dirty and of a heavy grade, proper combustion will not take place in the short distance. The results are that where specks of this oil strike the metal along the line of the weld the material will not amalgamate; the result is a defective weld. The burner should be placed so that it will not blow directly upon the material; better at right angles, either top or bottom. In some cases I have found that they mixed heavy crude with kerosene oil; this brought about better combustion and better results were obtained from the furnace. The heavy oil clogging the burner causes the temperature to fluctuate, and the material is wasted in the furnace without being given the proper degree of heat for welding. The temperature of the furnace should be kept above the welding heat; if possible, 300 deg. to 400 deg. F., and it is the opinion of the committee that it is necessary to use a pyrometer only in cases where the desire is to establish the proper heat for welding. This, however, is not necessary with an experienced flue welder, as his eye will readily detect the proper degree of heat for welding, and the pyrometer should only be used as a matter of education.

Use of the Electric Welding Machine

Welding safe ends by the electrical welding machine, in the opinion of the committee, will eventually supersede the present method. John Doarnberger, a member of this committee, for the benefit of the Association, has made a number of tests, both as to cost, quality of material, and strength of welds. He states that the average consumption of power is about 20,000 watts; or in other words, 20 kw. In considering the cost, the current is one cent per kw. hour delivered to the machine, and would cost about 20 cents per hour for current. Mr. Doarnberger claims that he can turn out about 85 flues per hour, which would make the cost per flue about ¼ cent for current. To operate this machine, however, it is necessary to have available alternating current, 60 cycle, with 110 or 120 volts. The machines will not operate on direct current but will operate very satisfactorily, however, over a wide range of voltage. The present machine at the Roanoke, Va., shop, Mr. Doarnberger states, has a minimum of 170 and a maximum voltage of 300, and under these conditions it is commercially possible to put them on any lighting or power circuit that may be available, providing the current is generated in a standard apparatus, or purchased from any ordinary lighting com-

pany operating under conditions as found in the average town.

The Norfolk & Western now has in service approximately 280,960 tubes welded by this method, 152,000 being welded in 1919, and no failures are reported. The Union Pacific is welding about 60 tubes per hour. It claims to have over 700,000 in service, and only two service failures out of this number, those that failed being in service more than three years.

Chamfering Safe Ends

In connection with electric welding tubes I find tubes and safe ends being chamfered to about 30 degrees at the Omaha shop and when the safe end is inserted there is a lap of about 3/16 inch, and this, in my opinion, is the better method; or, I would prefer it over the butt-welded, because if the material carbonized and broke off at the weld, after going into service, it would drop into the boiler. On the other hand, if it is lapped there is less liability of the tube breaking off from the safe end completely, and in this way there would be less damage.

At the Atchison, Topeka & Santa Fe shops I found the most up-to-date electric welding machine, which has a roller attachment on the machine, the tube being heated and rolled down without moving from the machine to the roller, as is the practice in other shops where the spot welder has no roller attachment. These people, however, are using the machine mostly for reclaiming, welding from 6 inch to 10 inch and about 35 or 40 tubes per hour.

Following is the strength of new 2¼-inch tubes without a weld:

37,820 pounds	
37,770 pounds	
38,030 pounds	Average 37,921⅔ pounds.
38,030 pounds	
38,030 pounds	
37,800 pounds	

COKE WELDED

31,130 pounds	
36,380 pounds	
28,370 pounds	Average 33,236⅔ pounds.
37,060 pounds	Efficiency 87⅔ per cent.
32,550 pounds	
33,930 pounds	

ELECTRICALLY BUTTWELDED

31,290 pounds	
37,240 pounds	
33,020 pounds	Average 34,020 pounds.
38,770 pounds	Efficiency 90.6 per cent.
33,450 pounds	
30,350 pounds	

The chairman of the committee has also conducted a test with 12 electrically welded two-in. tubes which proved to have an efficiency of over 90 per cent.

In conclusion, I wish to say that in most large shops—with the present method of furnace, roller and hammer welding—two men are employed in the welding, one piecing up and the other welding. In this way the tube is not allowed to cool off and it takes less time to heat; you might say this brings about continuous welding. I find that in most up-to-date shops they claim to weld about 50 tubes per hour, some places, however, are doing even better than that.

The report was signed by P. J. Conrath, boiler tube expert, National Tube Company, Chicago, Ill., chairman; J. A. Dearnberger and Alfred R. Stiglmeier.

Cause of Boiler Shell Cracking Through Girth Seam Rivet Holes

Your committee respectfully submits the following for your consideration:

One member of the committee after 45 or 50 years' experience can recall only 10 boilers which failed when the boiler shell cracked circumferentially. Five were locomotive boilers which cracked through the rivet holes at the external lap, two cracked through the rivet holes at internal lap, and one through the main plate at the abutment of the lap. Two return tubular boilers cracked through the rivet holes of the external lap. These boilers all developed cracks ranging in length from three to four feet, extending about equal distances to each side of bottom center line.

The locomotive boilers had double riveted girth seams and the tubular boilers single riveted girth seams. The girth seams in all boilers which cracked did not become defective because of a low factor of safety as they had factors in excess of that prescribed by both the governments of the United States and Canada. Not one of these cracks resulted in the explosion of the boiler.

The other two members of the committee, after making inquiries and observations from numerous railroads, find very few boiler shells cracking through the girth seam rivet holes and what has come to their attention was due to carelessness in preparing the sheets for riveting.

It must be quite clear to all of us that the plates in the steam space on the locomotive boiler must expand to a greater extent than the water space of the shell of the boiler, and the difference in the expansion between the top and bottom of shell in the locomotive type of boiler is dependent on the temperature of the steam at the top and the water below.

At first it would be thought that the top of the boiler would fail in advance of the bottom, but this is not so, because expansion is occurring equally and normally over every unit of its length, whereas the lower shell is subjected to a higher tension of stress brought about by the expansion of the top, which stress the bottom cannot equal because of its low temperature. This, in our opinion, causes the cracking of the shellplate through the girth seam rivet hole and the shell of the boiler, usually starting at the bottom.

It is our opinion that the rivet hole should be drilled in the girth seam and sheets properly prepared for riveting, and other improvements, which would quicken circulation such as applications of feed water with top checks located at the top of the boiler and at a distance from the fire; feed water heaters to raise the temperature of the feed water; automatic feed water regulation with regulators which would supply and keep the water as near as possible at a normal working level under all conditions. Also keep the expansion pads that secure the boiler to the frame free. Allowing the boiler to breathe and move freely in the frame will often prolong the rupture.

In our opinion with such improvements in general use on boilers the differential between the expansion of top and bottom of the shell would become more normal, with a reduction in the number of failures and the cracking of rivet holes in the girth seam, and the time of rupture be prolonged.

The report was signed by Andrew S. Greene, general foreman boiler maker, Big Four System, Indianapolis, Ind., chairman; William A. McKeown and T. W. Lowe.

Safety Code for Compressed Air Machinery

The American Society of Safety Engineers has been designated as sponsor for a safety code for compressed air machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization of apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

This work is being undertaken as part of a comprehensive program of safety codes in process of formulation under the auspices and rules of precedure of the American Engineering Standards Committee. The American Society of Safety Engineers was appointed sponsor for the code for compressed air machinery on the recommendation of the National Safety Code Committee.

Oxy-Acetylene Cutting Tests

BY JOHN C. EICHNER

A large part of the cost of any oxy-acetylene cutting or welding job is the cost of oxygen used and any method tending to reduce oxygen consumption without affecting torch efficiency is therefore of interest. The following test data were secured in tests recently conducted in a railroad boiler shop using a cut-weld torch made by the Alexander Milburn Company, Baltimore, Md. The tests were divided into two parts, one designated "Competitive" in which the manufacturer's expert demonstrators used the torches; and the second "Shop Conditions" in which one of the cutters from the boiler shop handled the torches. On the competitive tests the oxygen and acetylene gas pressures were set by the manufacturer while in the tests under shop conditions the pressures were those generally used in the shop for similar cutting.

The following schedule of tests was observed:

Competitive Conditions

300 ⅝ in. rivets cut from sides and end sills of steel hoppers.
100 ft. (approximately) cut from scrap locomotive firebox sheet.
3 holes 1¼ in. diameter cut through 5-in. locomotive frame.
3 smallest diameter holes cut through 5-in. locomotive frame.

Shop Conditions

100 ⅝ in. rivets cut from sides of steel hopper cars.
27 ft. (approximately) cut from new ⅜-in. steel plate.
83 sq. in. (approximately) cut from scrap steel tire 3 in. by 5½ in.
Back-fire tests.

In conducting these tests conditions were made constant for all torches as far as possible so as to get accurate comparisons both on the competitive and shop conditions. In the competitive tests a slight variation in conditions was caused by having to use a larger number of scrap firebox sheets than was at first thought necessary, because it was not possible to remove the sheets in large sizes. On the shop tests, conditions were identical in all cases.

DATA SECURED IN TESTS OF CUTTING AND WELDING TORCHES

		Based on hourly performance		Based on rivets, 25%; Firebox, 50% tire, steel, 25%	
		First test	Second test	First	Second
⅝ in. rivets	Number of rivets cut per hour	294	326	294	326
	Cost per rivet	0.0081	0.0075	0.0081	0.0075
	Cost per hour	2.38	2.45	2.38	2.45
⅜ in. steel	Sq. in. ⅜-in. steel cut per hour	450	527	450	527
	Cost per sq. in	0.00767	0.0059	0.0077	0.0059
	Cost per hour	3.45	3.11	3.45	3.11
3 in. tire steel	Sq. in. of 3 in. tire cut per hour	1,027	991	1,027	991
	Cost per sq. in	0.0052	0.0053	0.0052	0.0053
	Cost per hour	5.34	5.24	5.34	5.24
Total	Sq. in. cut in 3 hours	1,771	1,844	2,221	2,371
	Sp. in. cut in 3 hours	1,771	1,844	2,221	2,371
	Average cost per hour	3.72	3.60	3.66	3.48
	Average sq. in. cut per hour	590	614	555	593
	Relative values based on 1,000 sq. in. as unit of work—Cost per 1,000 sq. in	6.31	5.86	6.59	5.87
	Minutes to cut 1,000 sq. in	102	98	108	101

The tests of cutting rivets and plate were made primarily to obtain comparisons in economy and speed. The tests of cutting holes in 5-in. locomotive frames were made in order to cause the torch and tip to undergo fairly severe heat conditions without destroying the torch for further use. The test results shown herewith are based on observed and calculated data derived from the shop test.

Overcoming an Objectionable Column Where Crane Service Was Desired

BY NORMAN McCLEOD

It frequently happens that in some shop buildings the use of valuable space is prohibited because of the interference of a building column, especially if it is desired to have crane service over the space involved. In a specific instance of this kind the column was composed of two 12-in. channels and one 11-in. I-beam as shown at *A*, Figs. 1 and 2. As it was necessary to have crane service for the work in this department, it was decided to design a full circle, five-ton motor hoist runway jib with trolley, the whole to revolve completely around the column.

The design, as finally approved for installation, is shown in elevation in Fig. 1, details being given in Fig. 2. The trolley jib is composed of two No. C2 40-lb. Carnegie channels, spaced 10 in. apart and bent one to the right and the other to the left, as shown at *B*, Fig. 2. The jib is bolted to a casting, *C*, made in two parts with a runway race for 1-in. diameter steel balls, the whole to encompass and made to revolve around the column on ball bearings, shown in detail at *E*, Fig. 2. The upper casting is supported by a lower pair of castings, *D*, bolted permanently to the column. Castings *D* have a corresponding race for the above mentioned steel balls.

It will be noticed that in both top and bottom pairs of column castings, provision is made for a groove 1⅛ in. by 2 in., in which are placed steel tempered rings (in halves) with the usual V runways for the accommodation of a total of 69 one-inch steel balls for the bearings.

On the outer end of the trolley jib is a casting which acts as a spacer for the two 10-in. channels as well as a portable support for them as shown at *F*, Fig. 2. Two wheels, 9½ in. in diameter, provided with roller bearings, are employed to support the weight of the jib on the runway and provide as nearly as possible frictionless radial movement of the jib.

The outer end of the jib and any load which may be

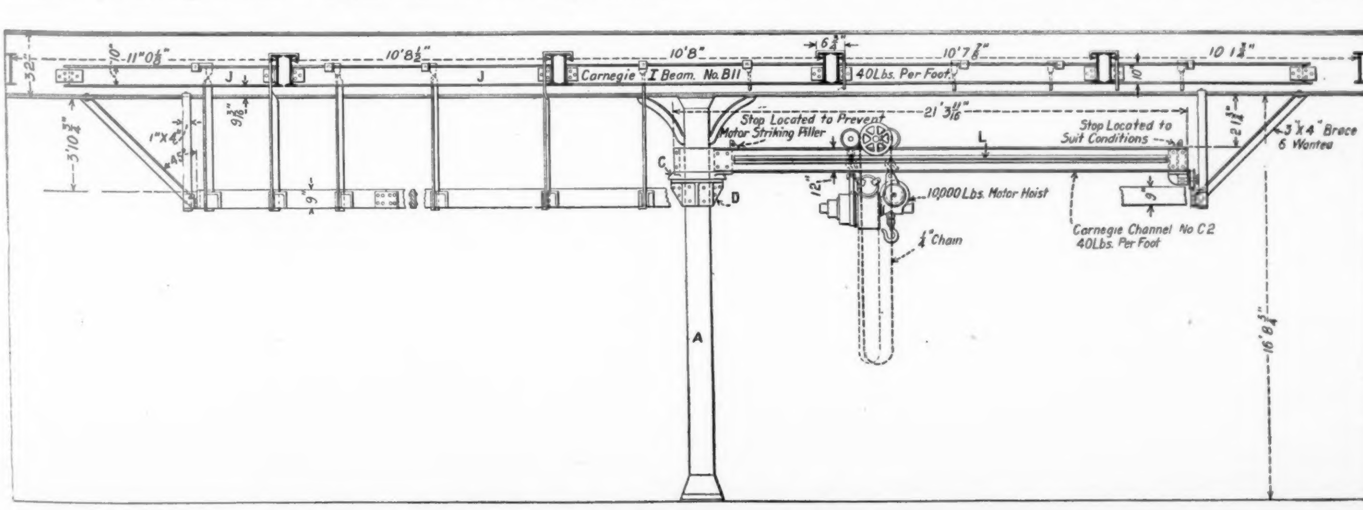


Fig. 1—Elevation Showing Column and Arrangement of Jib Crane with Motor Hoist

imposed upon it is supported by a circular 1½-in. by 9-in. wrought iron runway 41 ft. 0 in. in diameter. This runway is suspended from the ceiling above by 24 one-inch by four-inch wrought iron hangers (see details shown at *H*, Fig. 2), made to hook over the top of, and bolted to, the structural steel I-beams *J* which are framed into the steel beams used for supporting the floor overhead, as shown distinctly in Fig. 1.

A four-wheeled trolley traverses the jib a distance of 18 ft., and has two flanged and two blind wheels, the latter being keyed to the axle on which are keyed two 45-tooth wheels, engaging a pair of 19-tooth spur gears which in turn are operated by an endless chain thrown over a 14-in. sheave pulley. This arrangement enables the trolley position, with or without load, to be changed at the pleasure of the operator from the floor. Details of the trolley are shown in Fig. 2, which indicates the method adopted for suspending a five-ton motor hoist by means of two U-bolts, chain links and hooks.

In order to overcome the flexibility of the jib, the 10-in. channels were stiffened by placing a No. 54, 10-lb. Carnegie *T* on each side of them as shown at *L*, Fig. 1.

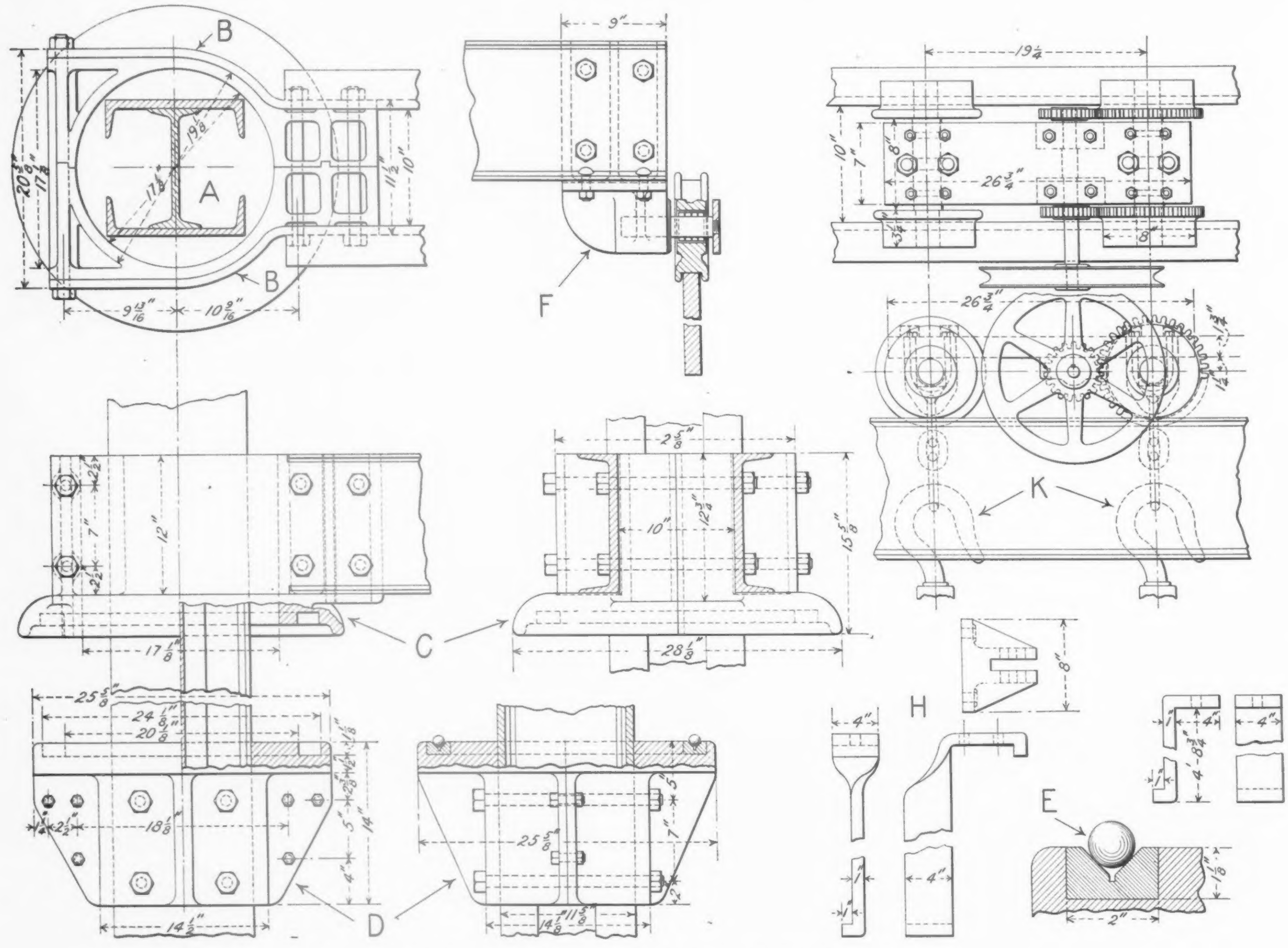


Fig. 2—Details of Column and Full-Swing Jib Crane Arrangement

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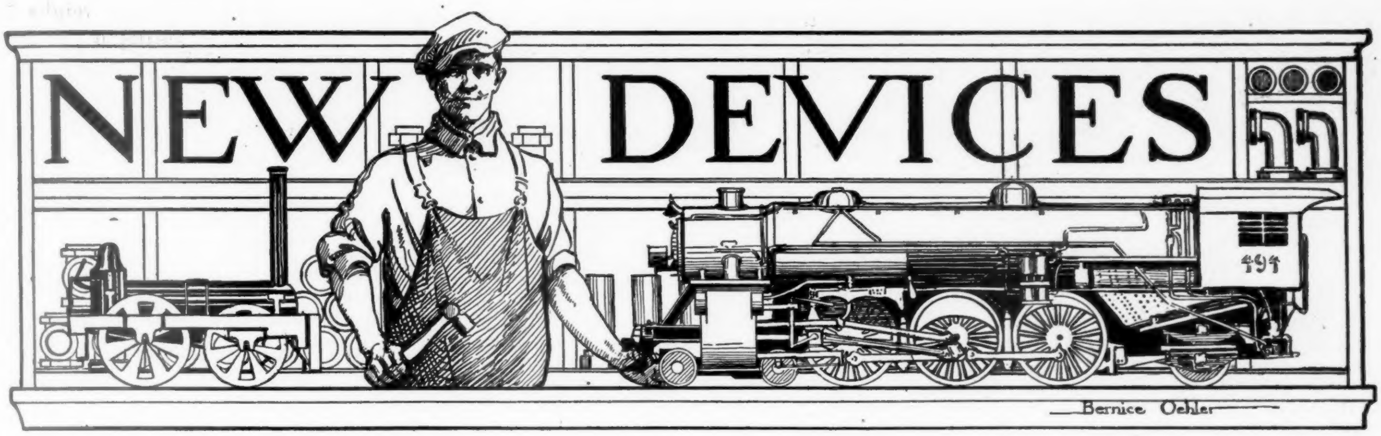
"In taking roughing cuts on cylindrical grinding machines," says Abrasive Industry, "a wide traverse feed should be used, as this will expedite production. The platen travel should be within ⅛ to ¼ in. of the width of the wheel for each revolution of the work. Fine traverse feeds in roughing operations with abnormal depths of cut is not as efficient as a wide feed with a comparatively light cut."

Keeping Shop Orders Clean.—In spite of the best efforts of any shop, the job tickets and the blueprints following a part through manufacturing processes are very likely to end up entirely illegible. This is not necessarily due to carelessness, as it is impossible to send papers along the route of the average machine part without having them pretty badly mussed up.

The practice of the Barber-Colman Company helps materially in preserving blueprints, job orders, job tickets, etc., routed through the plant. All milling machines, lathes, drill presses, etc., are equipped with a small rod bolted to the machine frame in such a manner as to be within easy reach and sight of the operator while the machine is working, and yet not be in the way. This rod rises 10 or 12 in. nearly vertically from the frame and is hooked at the end. The operator upon receiving a job, puts all papers accompanying it in an ordinary, strong paper clip, hanging the clip on this hook.

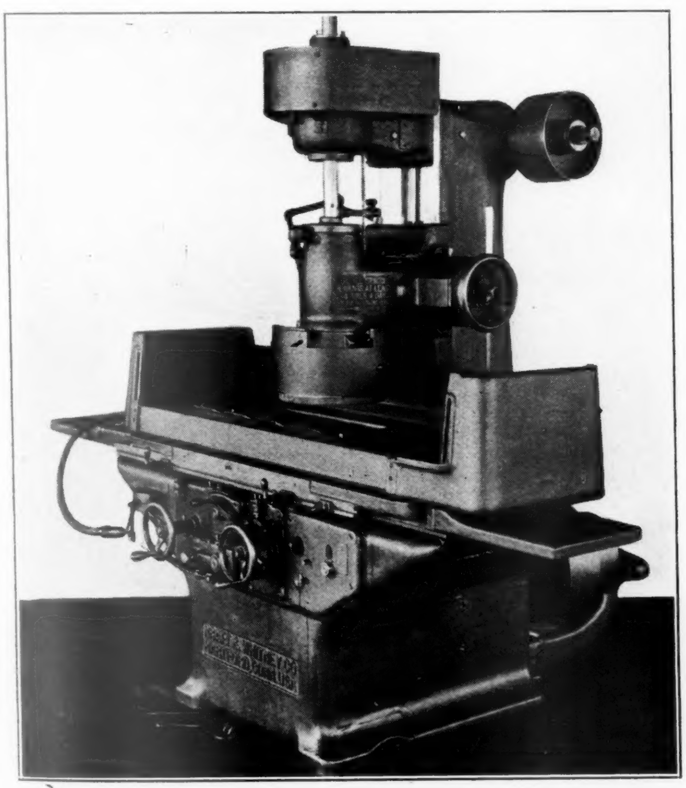
This serves a double purpose. All papers are kept in better condition, and are also more convenient for both operator and foreman. The foreman does not need to ask the operator any questions about the job, as all information is obtainable from the papers hanging on the hook.—*The Melting Pot.*

The production of soft coal increased slightly during the week ended October 15, according to the weekly bulletin of the Geological Survey. The total output is estimated at 9,696,000 tons, an increase of 573 tons over the week preceding.



Vertical-Spindle Surface Grinding Machine

ABILITY to handle work faster and more accurately than planers or milling machines, especially where small amounts of metal are to be removed at a single cut, is a feature of the new vertical-spindle surface grinder made by the Pratt & Whitney Company, Hartford, Conn. The machine is adapted for general surface grinding and for toolroom work on flat machine operations, such as the sharpening of blanking and forming dies. Another distinctive feature is the ability to handle, with equal efficiency, work requiring either a rotary or longitudinal movement. This feature, in conjunction with the simplicity and flexibility of the various work holding devices, makes the machine capable of handling an unusually wide range of work. The grinder is made in three sizes, including 8-in., 14-in. and 22-in.



Pratt & Whitney 14-in. Vertical Surface Grinder

The wheel spindle is supported by two well-proportioned brackets, scraped to correct position on the column, the entire spindle being mounted on ball bearings. The wheel is mounted on a face-plate screwed to the spindle so that it can be easily removed when replacement is necessary, the operator being protected from injury by a strong sheet-metal guard. An additional safeguard is provided by a safety band fitted around the wheel itself.

The table is of heavily ribbed construction, being equipped with three T-slots, furnishing adequate space for clamping magnetic chucks, special fixtures and in some cases the work itself. The length of stroke and reversal of the table are regulated by dogs, adjustable along a T-slot in the front of the table. A safety dog prevents the table from running off the ways. The table-driving mechanism operates through a safety friction which protects the gearing. The reversing-gears, clutches and drive shaft are hardened and ground to secure the greatest strength and wearing qualities. Two table speeds are provided, the operating clutch being controlled by a handle on the front of the gear box. The hand movement of the table is controlled by a hand wheel on the front of the gear box, which throws an auxiliary, drive pinion in and out of mesh. The wheel head is provided with both hand and power feeds. The power feed operates through a ratchet and pawl connected to the reversing lever. A hand wheel for rapid positioning of the wheel head is provided at the side of the column, the lower spindle head being counterweighted to provide for easy and rapid adjustment.

The main driving belt runs to the spindle pulley over idlers, mounted on well-lubricated roller bearings. The main drive cone runs on a stationary shaft containing felts for oil and is equipped with a bronze bearing. A liberal supply of oil is conveyed to the bearing felts through a hole in the shaft. Arrangement is made for an ample amount of coolant between the face of the grinding wheel and the work and this coolant being supplied at the inside of the wheel, prevents overheating and carries away the particles of metal and abrasive.

Motor drive is recommended on account of the size of this machine and the simplicity of installation and convenience of operation. The bracket carrying the motor is adjustable to permit alinement of the endless belt between the motor pulley and cone. With this type of drive a spring idler is also provided to take up belt slack. A 15-hp. motor is required for the 14-in. machine.

The grinder can be equipped with a rectangular or a rotary chuck, either being plain or magnetic. In either of the rotary chucks, a simple, rugged method of drive is incorporated, so designed that the drive engages automatically in the work position and disengages when the chuck is returned to the non-working position for re-loading. Chucks may be tilted, permitting the grinding of either concave or convex surfaces. A flexible coupling on the drive shaft takes care of the alinement when mounting.

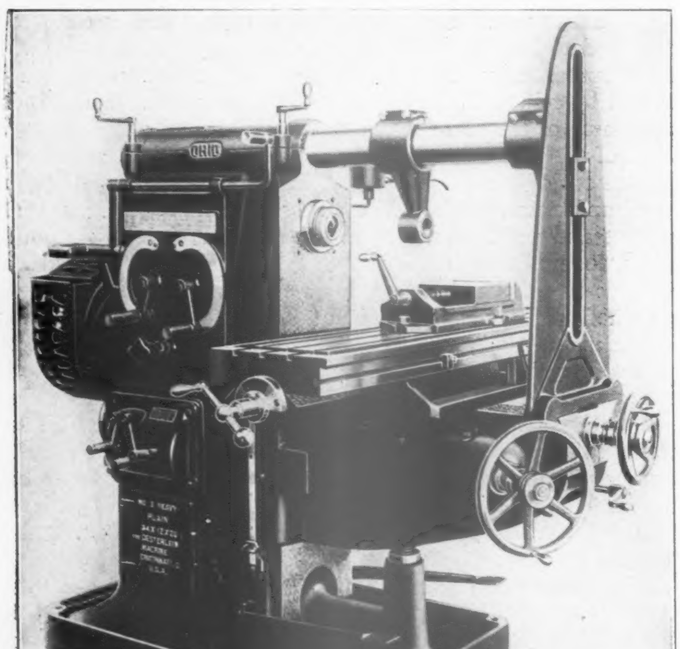
On the 14-in. machine the working surface of the table is

12 in. by 36 in., the distance from the table top to the grinding wheel being 14 in. The diameter of the grinding wheel is 14 in., its height and thickness being 4 in. and 1¼ in. respectively. The spindle speed recommended is 1,155 r. p. m., the rotary chuck speed being 103 r. p. m. Two power table feeds are provided of 34 in. and 142 in. per min. The table feeds per revolution of the spindle are .029 in. and .123 in. Two inches of table feed is obtained per revolution of the hand-wheel. The vertical feed of the head (1 to 10 teeth) is .0002 in. to .002 in. The machine weighs 7,400 lb. net with plain equipment, and the crating material for domestic shipments approximately 1,000 lb. more.

Constant Speed Drive for Milling Machines

THE Oesterlein Machine Company, Cincinnati, Ohio, has introduced a complete line of milling machines of the constant speed drive or all-geared type. The line consists of Nos. 1, 2, 2 (heavy), 3, 3 (heavy) and 4 sizes, each size being made either plain or universal as desired. The fundamental object of the new design was to produce a machine with all of the features essential to modern milling, reduce the number of parts to a minimum and increase the strength of necessary parts to a maximum. A study of these machines from that angle is interesting.

The speed mechanism consists of but 15 gears from which 16 geometric speeds are obtained. Only one shaft is employed in addition to the spindle and the pulley shaft. In obtaining 8 of the 16 spindle speeds, power is transmitted through a three or four-gear train. It has been found unnecessary to secure any of the 16 speeds by means of quadrants or similar unstable mechanisms, and this simplification of speed mechanism shows its results in the low power consumption of the machine. The no-load power loss of a No. 2 machine varies from 124 watts (.18 hp.) to 226 watts (.30 hp.) between the extreme spindle speeds of 16 to 384 r.p.m. This power loss includes the feed box at the highest rate of feed and feed mechanism within the knee and may therefore be regarded as practically the entire no-load power loss of the entire machine.



Oesterlein No. 3 Heavy Plain Milling Machine

The speed changes are secured by means of two two-position levers and a four-position knob. The four-position knob controls the selection of four adjacent spindle speeds. All speed changes may be made without stopping the machine. All gears in the machine are made from low carbon forgings, put through an annealing, carburizing and hardening process that produces a gear skin hard and tough. All gears are sandblasted to remove furnace scale and the wire edge of machining operations is removed in order to protect the bearings from this destructive refuse.

The automatic lubrication of the machine is effected without pumps or any extra moving parts. This is accomplished by a system of three reservoirs. The first reservoir is cast in the top of the column and into this reservoir clear, fresh oil is poured. This oil seeps through felt, down tubing to cavities cast under the main spindle bearings, to the intermediate shaft bearings and to the driving pulley. Wicks dip into the cavities under the spindle and carry oil to the spindle bearings proper. Thus it will be seen that only new oil is admitted to the heavily loaded bearings. The oil that passes through these bearings collects in the second reservoir, where it is distributed to the speed gears and minor bearings by splash lubrication. The overflow from the second reservoir passes to the third reservoir, which is the feed box, oiled by splash lubrication.

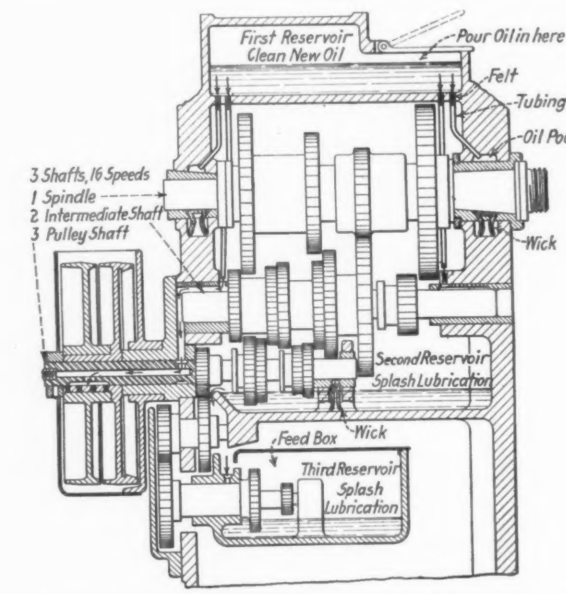


Diagram of Constant Speed Drive Arrangement

The capacity of the first reservoir is sufficient to supply the machine for about two months of ordinary service. Provision is made for correcting the level of oil in the third reservoir should this reservoir level decrease. This is accomplished by adding new oil and is necessary not more than twice a year. There are no oil holes within the machine to become clogged and any sediment of foreign matter in the oil lays harmlessly at the bottom of the reservoir.

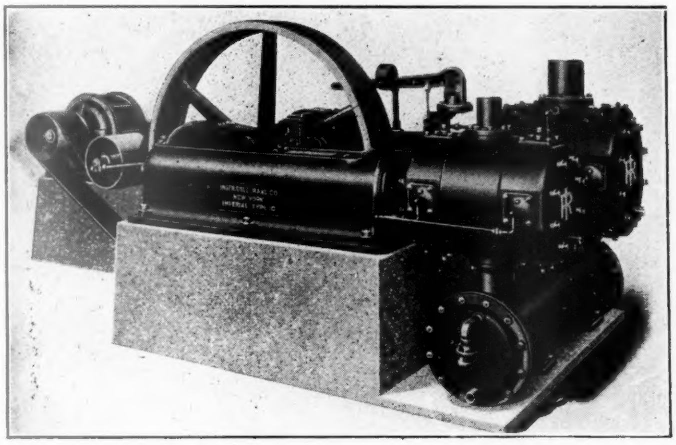
The driving pulleys are 14 in. in diameter and run at 400 r.p.m. Practical use is made of the high belt velocity by controlling the operation of the machine by tight and loose pulley, thus avoiding the expense, wear and complication of a clutch. A brake for quickly stopping the spindle is included in the belt shifter in such a way that the belt is partially carried to the loose pulley and the brake applied

to the tight pulley by a spring plunger release. The feed box is driven off the pulley shaft.

A phosphor bronze of from 28 to 32 points scleroscope hardness is used for all bearings and feed nuts throughout the machine. Cumberland ground steel of 45 to 50 point carbon is used for table, cross and vertical screws. The feed box, knee and table are similar to the design developed and used in the company's cone type milling machines.

Five-Step Clearance Control for Air Compressor

An air compressor, having plate valves for both the air intake and discharge and a five-step clearance control for regulating the output has been developed by the Ingersoll-Rand Company, New York. The plate valves used in this type of compressor are supported throughout their entire operation in correct alinement without any form of wearing guide, which insures a long life to the valves.

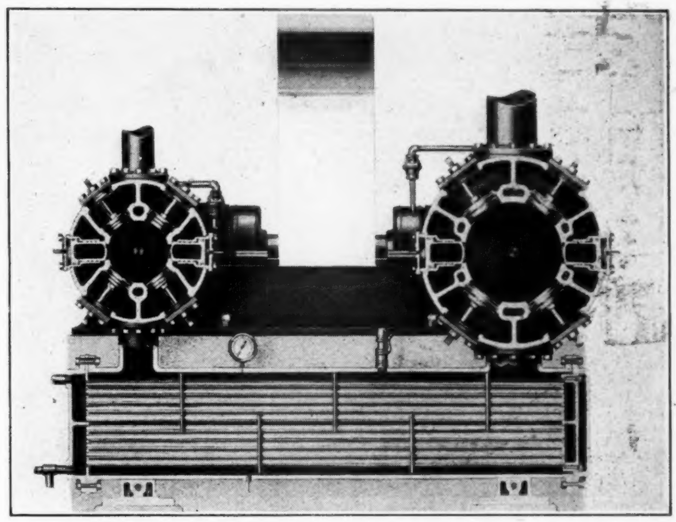


Ingersoll-Rand Short Belt-Driven "Imperial" Air Compressor

The clearance control was originally developed for use on the larger direct connected, motor driven compressors built by the same company, which have been installed in plants where more than 600 cu. ft. of free air per min. is required. With the clearance control, the compressor is automatically loaded or unloaded in five successive steps, obtained by the reduction or addition of clearance space to the air cylinders. Under this system a compressor will operate at full, three-quarters, half, one-quarter and no load and the control is so designed as to secure efficient operation at any step in this range.

A feature of the control is the fact that the clearance pockets are integral parts of the compressor cylinder and the entire regulation is obtained by the control of the volume of air taken in and compressed. The clearance pockets in the cylinder are automatically thrown in communication with the ends of each cylinder in proper succession, the process being controlled by a pre-determined variation in receiver pressure. With the compressor operating at partial capacity a portion of the air is compressed into an added clearance space instead of passing through the discharge valves. On the return stroke this air expands giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure, at which point the inlet valves are opened automatically and free air is drawn into the cylinder for the remainder of the return stroke.

On a two-stage compressor, clearance space in proper proportion is added simultaneously for both high and low cylinders giving a constant ratio of compression and maintaining a high compression efficiency throughout the entire load range. All the mechanism for regulating the compressor is independent of the compressor running gear. The new type of belt driven compressor equipped with clearance control is furnished in single stage for low pressures and two stage for higher discharge pressure. The piston displacement capacity for 100 lb. discharge pressure ranges from 610 to 1,505 cu. ft. of free air per min. This new type machine is described in complete detail in Bulletin No. 3042 sent out by the Ingersoll-Rand Company.



Section Through Cylinders and Intercoolers Showing Clearance Valves and Pockets

Knee-Type Surface Grinding Machine

A NEW design of surface grinder, brought out recently by the Graham Manufacturing Company, Providence, R. I., has been designed with the intention of employing only methods of construction which have been approved by time and practice. Novel, but well tried features, include the adjustable knee, table and pilot wheel, as well as the latest developments in bearings, abrasives, holders and dressers.

The abrasive ring holder is made of pressed steel, light in weight, and all parts are accurately machined to be in accurate balance. The abrasive ring is clamped by drawing a cone-shaped ring into a taper in the body. The adjustment flange screwed upon a large hub sets out the ring as it becomes worn. For dressing the wheel, any standard holder can be fastened on the table and the wheel quickly and accurately trued. Special care has been taken to so design the water guards around the wheel and about the table and trough, that the operator is amply protected from splashing of the cutting lubricant.

Any one of five possible methods of spindle drive is available but the one recommended is to have a motor mounted upon a bracket at the back of the column and

attached end-to-end to the grinder spindle by a flexible coupling.

In operation, the actual cutting is ordinarly done on that portion of the wheel indicated by the arrow (Fig. 1) which also shows the direction of revolution. The outside diameter of the abrasive ring is 12 in., the inside or hole, 7 in.; leaving a face 2½ in. wide. Grinding is seldom done on such a wide face, however, but usually on a face from ¾ in. to 1½ in. wide. In a general way the machine may be rated as having a capacity of 6 in. to 12 in. The top of the table will rise to the center of the wheel and drop 7 in. The extreme travel of the table is 16 in. and it can be moved back 3½ in. from the cutting face. Ordinarily, the head is set over just enough to give clearance. This is not sufficient to give a concave surface, though concaving can be done, and it is sometimes desired. Sometimes the

Fig. 1—Graham No. 41 Knee Type Ring Wheel Grinder

head is set perfectly straight, which greatly increases the capacity of the machine, and sparks will fly down at the arrow and upward on the opposite side.

The table block sets on the knee and has gibs fitted for movements in two directions. It is also fitted carefully with an adjustable nut that takes the cross-feed shaft and hand-wheel. This is indexed in thousands and regulates the depth of the cut. Ample oiling provision has been made as it is important to have the slides well lubricated. A special feature of the design is the provision of felt-packed dust collars to protect all running parts. Protected glass oilers indicate the height of the lubricant.

The abrasive ring holder is made with a heavy hub or center upon which a body of pressed steel, accurately machined, is fastened. The large portion of the center contains

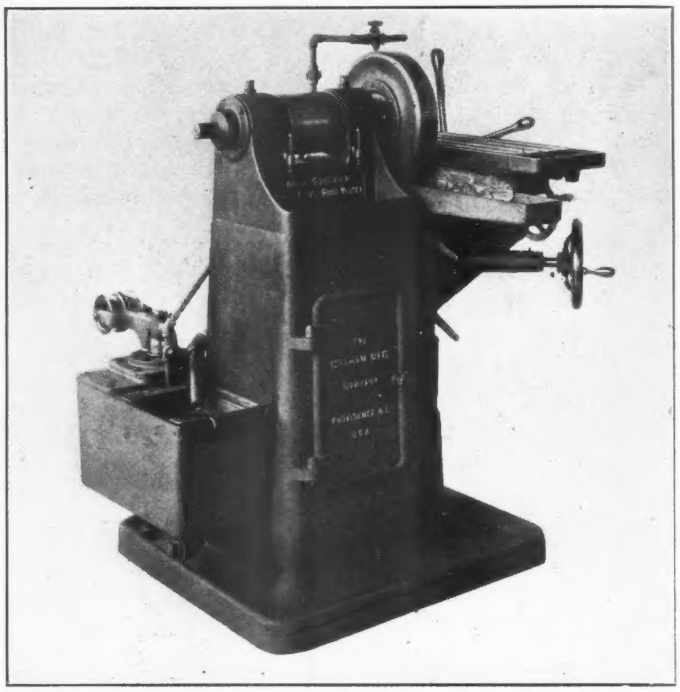


Fig. 2—Rear View of Graham Grinder Showing Tank

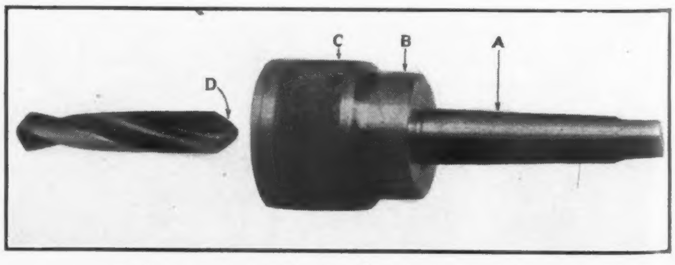
a setting-out nut with flange behind the abrasive ring to provide compensation for wear. The outside diameter of the abrasive ring is caught by a cone-shaped clamp ring drawn by several bolts into a taper machined in the body. The abrasive ring is 12 in. outside diameter, plus or minus .005 in., the height when new being 3 in. and when worn ½ in. or less.

Speaking of the machine as a whole, many modifications can be made, magnetic chucks furnished and automatic cross and table feeds applied. The height to the center of the spindle is 42 in., the table working surface being 10 in. by 24 in. and the weight of the machine 2,000 lb. For light work a 5-hp. motor is required driving the spindle at 1780 r. p. m. which gives a surface speed of 3700 ft. per min. on a neutral surface 8 in. in diameter.

Chuck Used With Broken Twist Drills

A DEVICE which makes possible the utilization of twist drills, broken at the shank, has recently been developed by the Wayne Tool Manufacturing Company, Waynesboro, Pa. The device is a chuck, simple in design, and quickly applied and removed without the use of tools. It consists of only six parts; shank *A*, casing *B*, two pawls, two screws and a knurled casing plate *C*, as shown in the illustration.

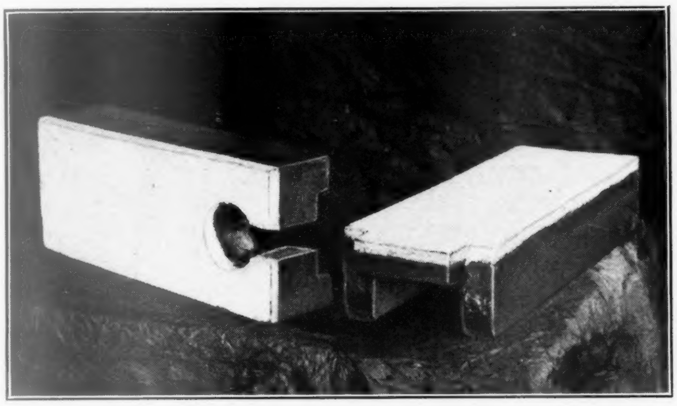
Broken twist drills are prepared for use in the chuck by grinding the broken end to a 60 deg. point as shown at *D* in the illustration. A corresponding recess is provided in the end of the chuck shank. This allows the drill automatically to center itself on being inserted in the casing and by turning the casing plate *C*, the drill is locked in place by means of the two pawls which grip the drill about the grooves. The drill is released for removal by turning the casing in the reverse direction.



Broken Drill Ready for Application in Chuck

Bronze-Faced Driving Box Shoes and Wedges

What promises to work important changes in methods of maintaining locomotive driving box shoes and wedges, effecting important savings in maintenance costs, is the development of bronze-faced semi-steel castings by the Standard Semi-Steel Foundry Company, Clinton, Mo. Shoe and wedge castings have been made of this material in which the bronze faces proved to be 30 per cent harder than ordinary bronze, the backs being made of semi-steel approximately 50 per cent stronger than grey iron. The combination of these two metals affords valuable wearing properties and the strength that is so essential in shoes and wedges. Bronze-faced shoes and wedges, such as are shown in the illustration, have been used for 16 months on two important railroads with no difficulty being encountered due to the separation or loosening of bronze faces under the constant hammering.



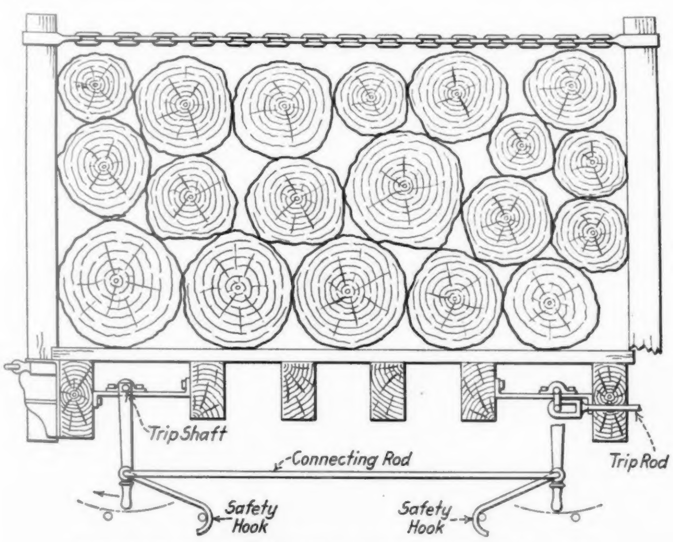
Semi-Steel Shoe and Wedge With Bronze Faces Outlined in Chalk

Different railroads use different methods of handling shoe and wedge maintenance work. Some rivet brass plates to the shoes and wedges and others apply brass to the driving boxes, while in still other cases solid brass shoes and wedges are used. It has been found in the first two methods that the use of bronze-faced shoes and wedges effects a large labor saving and is extremely satisfactory, doing away with the pounding from loose liners as there has never been a case where the bronze separated from the semi-steel. In cases where solid brass is used it has been found that shoes and wedges wear very fast and do not stand up to the work imposed upon them, moreover, the first cost is much greater. The use of the bronze-faced material has been found to be an advantage to the roundhouses inasmuch as a large amount of pit work in adjusting driving boxes and changing shoes and wedges is reduced or eliminated. It has been suggested in cases where a road uses the method of dovetailing driving boxes and then pouring on brass, the change to bronze-faced shoes and wedges can be made by welding a steel plate over the driving box face, thus covering the dovetail slots and enabling the old driving boxes to be used.

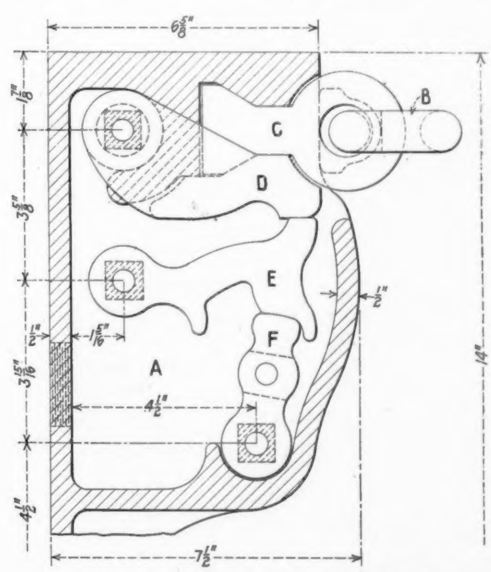
The question of reclaiming bronze from the scrap came up soon after bronze-faced shoes and wedges were developed. After experimenting it was found that by putting the shoes and wedges in an oil furnace, heating them to a little more than cherry red, a blow with a sledge hammer separated the two metals. The cost of reclaiming the bronze was about 25 cents per hundred pounds and it is worth about two dollars per 100 pounds more than ordinary scrap brass. The combination of bronze and semi-steel in one casting is secured by special mixtures and careful molding.

Safety Stake Pocket for Logging Cars

Various types of stake pockets have been invented for logging cars, the majority of which are equipped with permanent stakes hinged at the bottom and a mechanism which when tripped allows the stakes to swing out and dump the load. Such stakes, however, are used principally on small logging cars. A new type of stake pocket, particularly adapted for use on standard flat cars and having an effective safety feature, has been invented by A. D Adams, Gulfport, Miss. In this design the stake, instead of swinging about a pivot at the lower end, is entirely released at the bottom, when it is desired to dump the load.



Arrangement of Operating Levers and Safety Hook



Details of the Stake Pocket Mechanism

The construction of the stake pocket is shown in one of the illustrations. The entire operating mechanism is placed in one side of the body *A*. Part *B* is a link, one end of which passes through an eye bolt on the opposite side of

the stake while the other end is held by the retainer *C*. The wedge shaped end of the retainer is held by lock *D* through the action of latch *E* and trip *F*. The stake fits between the body of the stake pocket and the link *B* which is firmly held in place while the parts are in the position shown. It is evident if the trip *F* is moved to the left, the latch *E* and lock *D* will drop, releasing the retainer *C*. Link *B* is then free to swing in the eye bolt to which it is fastened at the opposite end and will be forced out by the stake, releasing the load.

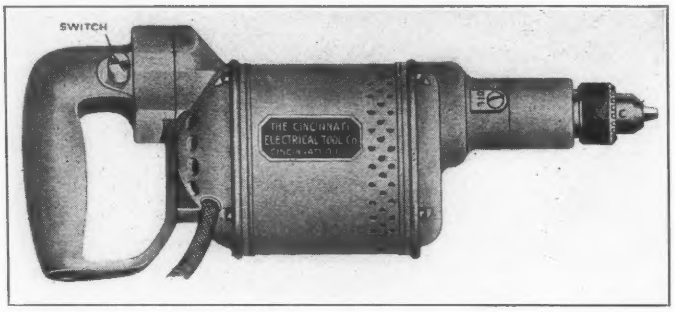
The mechanism by which the release is effected is also illustrated. The trips are operated by trip rods which are connected across the car by rods and levers as shown. The lever on each side has a safety hook which fits over a truss rod preventing unintentional or improper release of the stakes.

When ready to dump the logs, the operator proceeds to the opposite side of the car from which they are to be unloaded, raises the safety hook and pulls the lever to which it is connected. This releases all the stakes on the opposite side of the car simultaneously so that the logs can roll off. As the stakes are chained together at the top, the logs roll out under them, leaving the stakes ready to rearrange for loading again. When the safety hook on either side of the car is raised, it allows the lever to be pulled, releasing the stakes on the opposite side. The arrangement is such that it is impossible to dump logs on the operator, for the safety hook on the opposite side makes it impossible to push the lever toward the center of the car which movement would dump the logs on the side on which the operator is standing.

Ease of Operation Features New Portable Drill

A LIGHTWEIGHT, portable electric hand drill of 3/16-in. capacity with pistol grip is the latest addition to the line of portable electric drills and grinders manufactured by the Cincinnati Electrical Tool Company, Cincinnati, Ohio. This new drill answers the need for a light and practically frictionless but high speed and powerful tool, adaptable to all kinds of light drilling. It is suitable for drilling in steel, brass, aluminum and sheet metal and for car building, window frames, etc. It also makes a very practical tool for wood boring.

While thoroughly simple in construction, the new drill is compactly and substantially built. It is equipped with a universal motor for use on direct and alternating current of the same voltage. The motor housing, end caps and handle are made of special aluminum, insuring minimum weight consistent with strength. The armature and gear studs are mounted on ball bearings which practically eliminate friction. Gears are of special analysis high grade steel. The switch



Portable Electric Drill With Pistol Grip

is the Cincinnati quick make-and-break type with 50 per cent overload allowance. It is entirely enclosed in the handle and is operated by a trigger conveniently located in the handle.

Locomotive Throttle Rod Stuffing Box

THE throttle rod stuffing box illustrated is a recent development of the Gustin-Bacon Manufacturing Company, Kansas City, Mo. A view of the new stuffing box is given in Fig. 1 and a particular feature of its construction is that additional valve stem packing can be applied

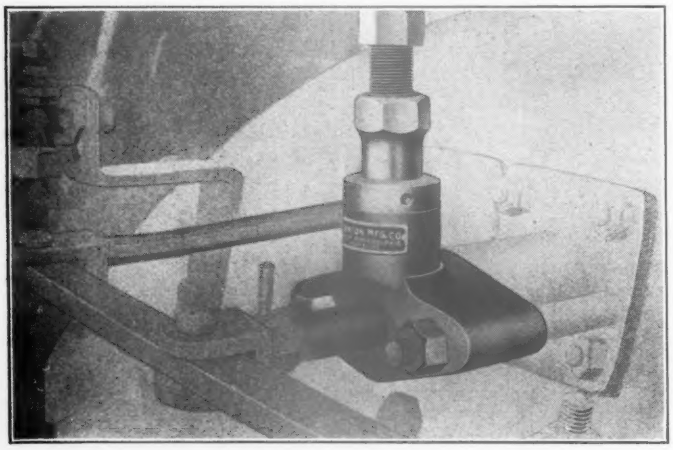


Fig. 1—Throttle Rod Stuffing Box in Position on Boiler Head

and leaks stopped while a boiler is still under steam pressure.

Referring to Fig. 2 the construction of the device will be evident. The front section of the stuffing box *F*, fits over the throttle rod and forms a ball joint with the boiler head, being held in place by two stuffing box studs. The main stuffing box *B* forms a joint with the front section by means of copper gasket *G* and is held against the gasket by two bolts shown

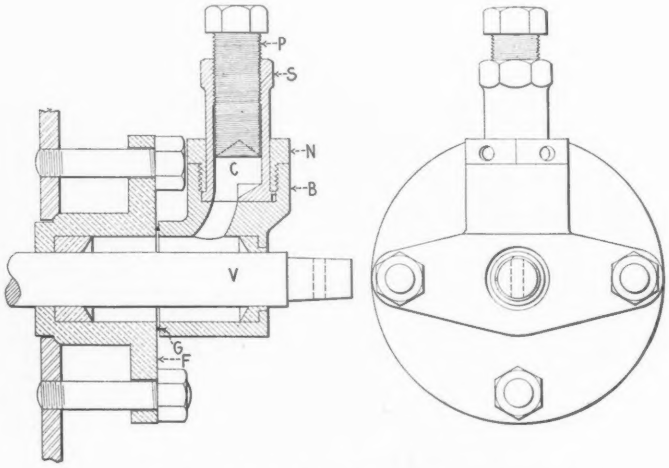


Fig. 2—Details of Stuffing Box Construction

in the end view. A plunger *P* is arranged to screw into sleeve *S* which is a running fit in spanner nut *N*. The storage chamber *C* is provided to receive the plastic packing

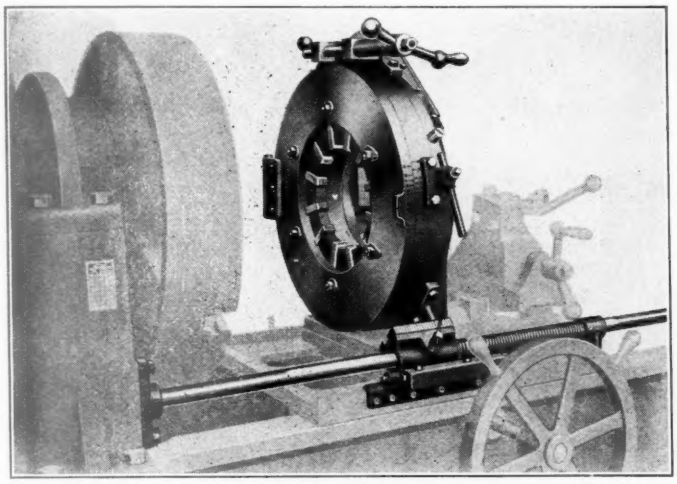
which is forced into the stuffing box through the passageways indicated. The port between storage chamber *C* and the stuffing box can be opened or closed by revolving sleeve *S*.

The normal position of the sleeves when operating is with the port open. Should a leak develop, a slight tightening of plunger *P* will stop it. In case it is desired to furnish an additional supply of packing to the stuffing box with the boiler still under steam pressure, it is only necessary to turn the sleeve *S* until the port is closed. Plunger *P* can then be removed and the storage chamber *C* filled with packing without danger of the escaping steam.

Only one style and size of stuffing box is required since variations in rod diameter can be accounted for by varying the front and back end throat ring bores. G-B plastic packing is composed of small tubes which are forced into a homogeneous mass around the throttle rod by the plunger. Scored and worn throttle rods which are difficult to keep steam-tight on account of set packing not adapting itself to irregularities, are said to cause practically no trouble with the use of G-B plastic packing—which conforms to the shape of the rod when forced into the stuffing box. The position of the plunger in the stuffing box indicates when additional packing is required and this indication is plainly evident to the enginemen or roundhouse engine inspectors.

Receding Die Head for Pipe Threading Machine

In order to cut pipe threads to any desired taper and length, the Williams Tool Corporation, Erie, Pa., is now equipping its power pipe machines with a patent receding die head. In the usual type of head the correct taper can only be cut the width of the die and where a longer thread is required, the only solution is to procure wider dies. This requires special dies and is often impracticable.



Williams Receding Die Head Set Up Ready for Operation

Another threading difficulty is caused by the increased use of soft open-hearth steel in the manufacture of pipe. The cuttings from this grade of steel have a tendency to clog in the teeth of the dies and tear the tops of the thread. This is a characteristic of the steel itself and is a difficulty encountered in threading all products made of this material.

The new head has been so constructed as to cut any degree or length of taper, and also make the cutting easier, having more cutters and teeth designed to reduce chip clogging to a minimum. A narrow die is used and it recedes as it runs on the pipe, opening automatically to give the desired taper and making the length of thread cut independent of the width of the die.

It will readily be seen that the heaviest cutting is at the start, decreasing as the dies run on the pipe and reaching a minimum at the finish. This is exactly the reverse of the action of the old type of head, consequently the cutting will be much easier, using less power and having less tendency to clog. Another feature which tends to give better threads is that the heaviest cutting is done by the front of the dies, the back ends merely cleaning up the threads.

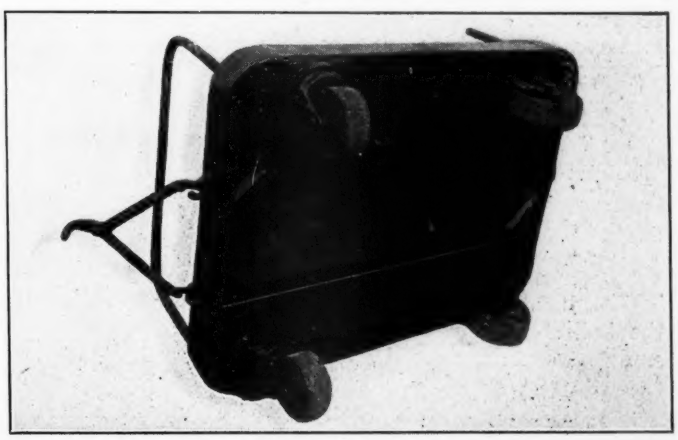
The new Williams receding die head is now furnished with all eight models of pipe threading machines which cover a range of pipe from 1/4 in. to 16 in. inclusive.

Heavy Duty Trailer for Concentrated Loads

The movement of heavy concentrated loads such as large castings, etc., constitutes an important handling problem in railway freight stations, warehouses and repair shops. In such work, cranes, trucks, tractors and trailers and various other material handling devices are being increasingly used. For such work the Sharon Pressed Steel Company, Sharon, Pa., has developed a trailer specially designed for heavy duty service with tractors.

The trailer frame consists of four 3/8-in. channel sections which are pressed from 1/8-in. hot rolled open-hearth steel and riveted into one-piece channel section corner pieces pressed to a 6-in. radius. By varying the length of the side and the end rails, the trailer can be made in any length up to 72 in. and in any width up to 50 in. Two additional members, of 3-in. pressed steel channel, run lengthwise beneath the floor and are riveted to the end rails and braced, laterally, to the frame with front and rear pressed steel "V" braces which take the pull of the 5/8-in. steel forged coupler. Either one or two couplers can be used.

The rear wheel and front caster supports are 3-in. pressed steel channels riveted to the side rails and the longitudinal members of the frame. The rear wheel brackets are pressed from 1/4-in. steel with two stiffening ribs on each side. The rear wheels are of malleable iron with six double-web spokes and 3 1/2-in. face and are equipped with 3-in. Hyatt roller bearings on a hardened and ground 1-in. shaft.



Under Platform View Showing Construction Details

The front casters are of heavy-duty type, ball and roller

bearing equipped, bolted to a ½-in. steel plate which is riveted to the frame. The floor of the trailer is 1¼-in. oak recessed flush in the side and end rails. All frame members are flush on the bottom, thus affording an even support when the trailer is used in connection with a lift truck, such as is now coming into quite common use.

The trailer was recently given a severe test with a load of 8,000 lb., indicating its adaptability to exacting service.

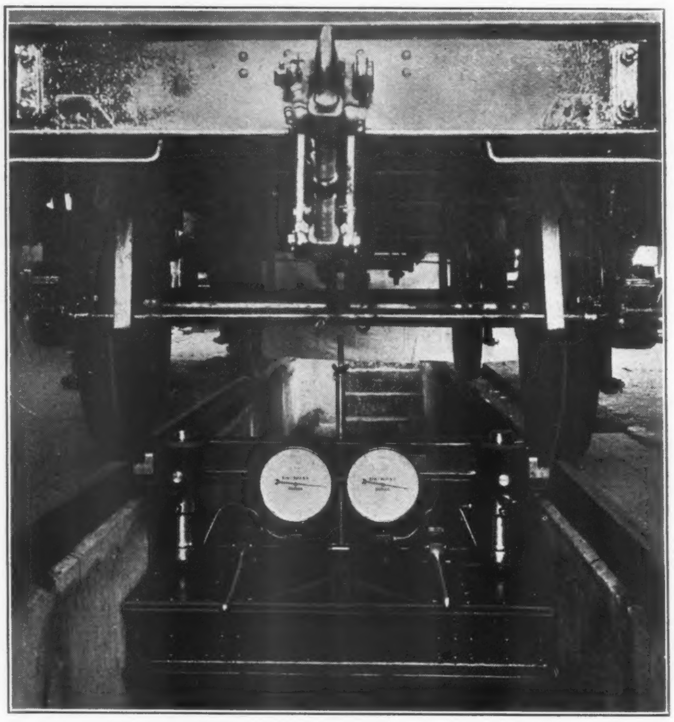
Measuring Locomotive and Car Wheel Loads*

A NEW device for measuring the loads on locomotive and car wheels and finding the pressures with which the wheels bear upon the rails has been developed by Alfred J. Amsler & Company, Schaffhouse, Switzerland, and is being sold in this country by Holz & Company, Inc., New York. As shown in the illustration, the complete apparatus consists of two different parts, the measuring machine proper and the carriage for moving it about under the cars. The carriage is a strongly-braced structure provided with two wheels at each side, and these run on narrow-gage rails set in a pit below the vehicles to be weighed. In this way the cars need not be moved during the weighing operation, and only the measuring machine is moved along on its carriage from one axle to another between each reading.

The weighing apparatus is centered on the upper crossbar of the carriage and comprises two oil presses, the pistons of which are so accurately fitted in the cylinders that no packing is required to ensure sufficient oil-tightness. The motion of these rams is therefore practically frictionless, and hence the oil pressure acting in the cylinders measures the load on each of the presses. The pistons both act near the ends of a single cross-beam, the projecting lugs of which engage the wheel flanges of the axle to be weighed. These supports are mounted on spherical seatings so that they support the wheel truly at each end. The transmission of the load between the piston and the cross-beam is effected through a suspension cap and spring-centered pin, so that the piston is not acted upon by any side pressure. The cross-beam is in turn attached to the suspension caps by means of pivots so that no side effort can be produced.

The presses are each connected with a hand pump which serves to raise the cross-beam and eventually the car wheels are raised. The oil pressure, acting in each press immediately the wheels are raised, is a measure of the wheel loads, and these are read off on the two pressure gages, graduated in tons. A simple release valve, on being opened, discharges the oil presses and lowers the wheels gently onto the rails. During the load reading, the pistons of the oil presses are rotated slightly by means of the rocking levers, which are connected by the bar at the back. This completely eliminates any friction which might exist between the piston and the cylinder.

A centering rod, running between rollers on the machine base-plate, is provided with an adjustable stop which is set before the weighing carriage is run under an axle. This enables the machine to be brought immediately below the axle to be weighed, then the rod is lowered, and kept down during the weighing operation. It is best to keep it lowered when passing from one axle to another. When not in use the weighing portion of the apparatus may be detached from the carriage and stowed away in a suitable place. Only one screw need be unfastened to free the apparatus which can be lifted by two men. To check the pressure gages occasionally the packing of the pump pistons can be slackened off when they will work without friction. A weight of one pound hung on the hook at the end of the pump handle produces a pressure equal to a load of 500 lb.



Amsler Wheel Load Measuring Device

*Abstract of a description in the Railway Engineer, November, 1920.

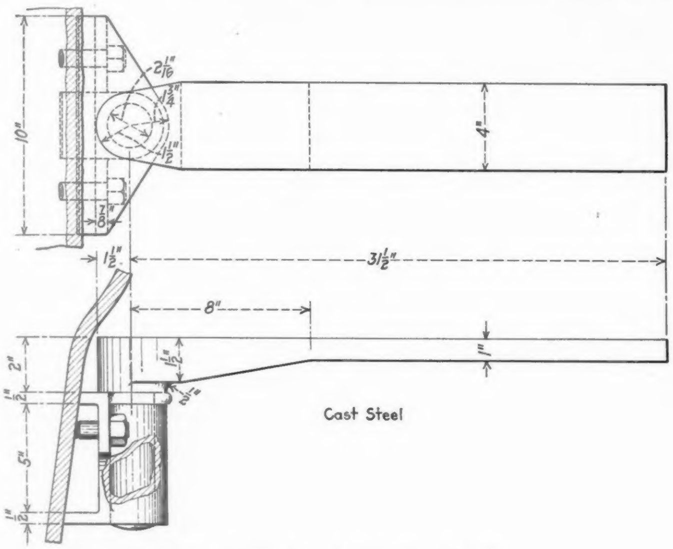
Easily Detachable Running Board Bracket

EASE of application and removal are features of a recently devised running board bracket which has the additional advantage of swinging back against the boiler in case of a wreck, thus avoiding pulling out studs with consequent danger of scalding with hot water and steam.

The ordinary type of running board bracket is usually formed from a bar of iron or steel bent to approximately a right angle and fitted to the boiler. The part coming in contact with the shell of the boiler is secured with studs to the shell and the outer part of the bracket helps support either the cab or running board. In the event of a locomotive being side-swiped, if the side of the cab or running board is struck, the running board bracket will often be pulled off with sufficient violence to pull out the studs, permitting live steam to escape and scald anyone in the immediate vicinity. Even if the studs are not torn out of the boiler or broken, they will have to be cut off to release the damaged bracket, and there is considerable expense in removing, repairing and replacing a one-piece running board bracket.

In the new running board bracket design illustrated, the hinge principle has been adopted. The base or socket portion of the bracket is secured to the boiler shell by means

of studs, or in the usual manner. That portion of the bracket which supports the cab and the running board is at its inside end formed in the shape of a pin at right angles



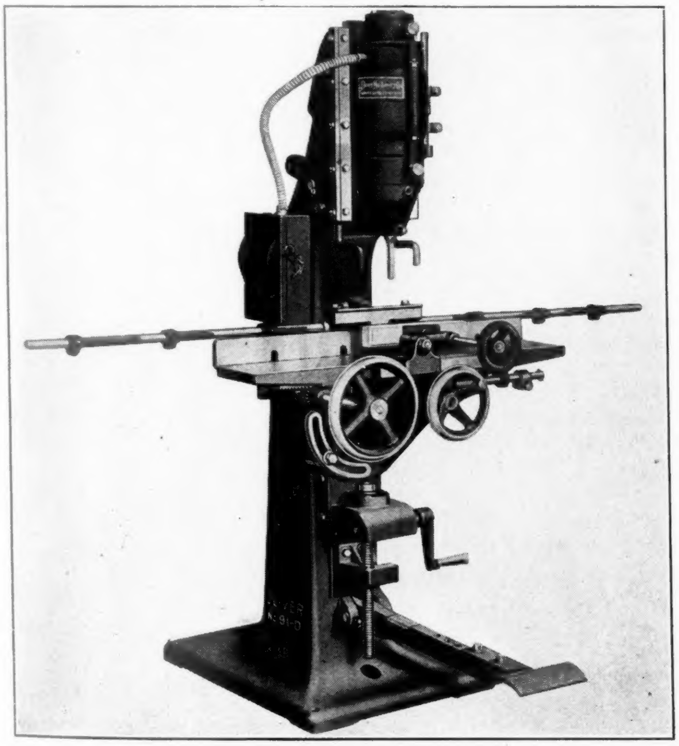
Hinge-Type Running Board Bracket

to the main or flat portion of the hanger to which the running board and cab are fastened. This pin enters the socket which is bolted to the boiler shell, thus forming the completed bracket. The running board and cab are riveted or bolted to the bracket and in the event of a side swipe or other accident affecting the running board, the weakest portion is the running board itself or the bolts which fasten it to the bracket. These are broken or sheared off and the bracket simply folds against the side of the boiler without disturbing the studs which enter the boiler shell. Even if the equipment coming in contact with the locomotive approaches so closely to the boiler as to come in contact with the socket portion of the bracket, the socket is so designed as to present a small flat surface to receive the blow, and it would rather cause it to glance off. In other words, any accident which would damage the socket or tear out the studs securing it to the boiler would be almost certain to damage the boiler itself.

The device has performed satisfactorily under service conditions and in addition to being a safety device it effects a considerable saving in the cost of repairing a locomotive that has been side-swiped. In the majority of the cases the damaged running board would simply be removed, the brackets turned back to their normal position and another running board bolted in place. In case the lagging must be removed the time saving feature of this device is readily apparent. The fact of the running board being bolted to the cab's bracket or tail board together with the weight of the cab itself prevents any movement of the running board in ordinary service. A patent on this running board bracket has been issued to C. B. Baker, 3865-A Flad Avenue, St. Louis, Mo.

Direct Motor Drive Applied to Mortiser

An interesting application of direct motor drive to a vertical hollow chisel mortiser is shown in the illustration. The motor operates at a speed of 3,600 r. p. m. on either two or three-phase, 60 cycle, alternating



Oliver Motor Driven Hollow Chisel Mortiser

current and is built into the mortising head or ram of the machine, this construction providing a shaftless motor.

The housing for the motor forms the motor head and the motor itself does not have any bearing, its rotor being mounted directly on the spindle, which runs in ball bearings. The motor is connected to a safety-first, enclosed starting switch with fuses, by means of a flexible conduit. The machine itself is equipped with a compound table having hand-wheel rack and pinion feeds and a clamp for the work. The usual bushings, wrenches and similar equipment are provided.

As in the usual construction of hollow chisel mortisers, the cutting tool is operated by means of the foot treadle shown in the illustration. The working table is capable of movement by means of the large hand-wheel shown, the motion being transmitted through a small pinion and rack underneath the table. Arrangement for swiveling the table in case it is desired to mortise at an angle is made by means of the quadrant and locking nut shown in the illustration.

The principal advantages of this new construction is in the elimination of a countershaft and new pulleys and belts. Floor space is saved and the machine may be arranged in the shop regardless of line shafting. The machine is self-contained and is said to be cheap to operate on account of the efficient motor drive. The cost of up-keep is also small. This mortiser has been developed and placed on the market by the Oliver Machinery Company, Grand Rapids, Mich.

Regulating Fire Thickness.—Finding that the horsepower needed was not being developed in his power plant, an eastern manufacturer had curves made of the boiler performance. In one set of curves the horsepower developed and the over-all efficiency of the boiler were plotted against the thickness of fire.

From this curve the engineer discovered that there was one particular thickness of fire where the efficiency was greatest. With this thickness the greatest horsepower could be developed, but the curve fell off steeply on each side of this point, showing that a slight variation in thickness could develop considerable power.

The surprising fact was that the thickness at which the boiler operated most effectively was not that at which the firemen had thought best results were obtained.—*Factory.*

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WE GUARANTEE, that of this issue 7,700 copies were printed; that of these 7,700 copies 7,018 were mailed to regular paid subscribers, 11 were provided for counter and news company sales, 229 were mailed to advertisers, 8 were mailed to employees and correspondents and 434 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 100,550, an average of 9,141 copies a month.

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Mechanical Convention at Atlantic City

The Executive Committee of the Railway Supply Manufacturers' Association met at the Waldorf-Astoria Hotel, New York City, October 26, 1921. The situation was thoroughly discussed regarding the meeting and exhibits of the Association for 1922. The letter ballot as to the preference of all members indicated a three-to-one vote in favor of the meeting and exhibits. The letter ballot and reports from the various members of the committee, representing all parts of the United States, showed also that the members were decidedly in favor of going to Atlantic City for the meeting and exhibits. A formal vote was taken and it was unanimously decided to hold the 1922 meeting and exhibits in Atlantic City.

The General Committee of Division 5—Mechanical, American Railway Association, held a meeting in New York City on the afternoon of October 6, and decided unanimously to hold its annual convention at Atlantic City, June 14 to 21, 1922. Division 3, American Railway Association (Purchases and Stores) will be invited to hold its annual meeting at the same time and place.

A fire which swept the Chicago, Rock Island & Pacific shops at Pratt, Kan., on October 7, destroyed the repair tracks, car sheds, carpenter shops and 25 box cars; estimated damage $200,000.

Abolition of the United States Railroad Labor Board and all other existing national labor adjustment boards was urged in resolutions adopted by the 28th annual convention of the National Implement and Vehicle Association at the Congress Hotel, Chicago.

The Pennsylvania Railroad, since May 15, has taken on about 14,000 men, the total number of employees now being 199,000, as compared with 184,625 on May 15. President Samuel Rea, in giving out these figures, said: "It is the purpose of the Pennsylvania to co-operate as far as possible with President Harding's efforts to reduce unemployment. It is our hope that still more men will be needed. We intend to utilize the additional men chiefly in putting our idle cars in order prior to the coming of winter. We have at present on the Pennsylvania system 82,149 idle cars, of which 46,691 have been stored without being repaired. None of the latter are required for current use, or, as far as can be foreseen, are likely to be needed this fall. In all probability it might be perfectly safe to defer their repair until next spring, but we feel that if we put them in order we shall not only be prepared for a revival in business but shall also be assisting in President Harding's endeavor to improve the general employment situation."

Mechanism in Constant Use Without Injury Held Safe

The New York Court of Appeals holds that, when it comes to a question of proper condition and safety under the Boiler Inspection Act, mechanism which has been in constant use for years without causing injury must be considered proper and safe until some notice or occasion indicates its danger and insufficiency.—Ford v. McAdoo (N. Y.) 131 N. E. 874.

Anthracite Shipments in September

Shipments of anthracite for September as reported to the Anthracite Bureau of Information, amounted to 5,519,412 gross tons, against 5,575,115 tons in August. The loss in production due to the shutting down of some mines in the Scranton district that cannot be operated under the provisions of the Kohler act, was something over 200,000 tons, about three-fourths of which loss was made up by increased shipments from other districts. The total shipments for the coal year beginning April 1, have amounted to 34,350,584 tons, as compared with 33,479,753 tons for the corresponding period in 1920, a gain of 870,831 tons.

Fraudulent Pay Checks

Three men arrested at Pittsburgh, Pa., and brought into court on October 7, on charges of conspiracy to defraud the Baltimore & Ohio Railroad, were found to have cashed a large number of counterfeit pay checks; and to identify themselves, when making purchases, they used counterfeit railroad passes, written on blanks which they had printed. All three pleaded guilty. One was an employee and another a former employee; and two other men, including a printer, are yet to be caught. In passing checks amounting to $1,412, the thieves had received more than $1,000 in change.

Convention of American Electric Railway Association

The report of the Committee on Heavy Electric Traction of the American Electric Railway Association was presented at the annual convention, held during the week beginning October 3 at Atlantic City, N. J. The committee outlined the work in progress by the A. E. R. A. and other societies in America interested in heavy electric traction, and suggested that much of the present duplication of work should be done away with. The term heavy electric traction was defined as it applies to locomotives and multiple-unit equipment, a progress report on electric switching locomotives was made, comparative advantages of locomotives and multiple-unit cars were outlined and much data presented in the form of chart, tables, and a bibliography.

Westinghouse Receives Additional Order From Chile

The Chilean State Railways have ordered six express passenger electric locomotives from the Westinghouse Electric International Company. This equipment is in addition to the 33 electric locomotives and other electrical material the contract for which the Westinghouse Company received several weeks ago, as noted in the October issue. This equipment will be used in electrifying the Chilean State Railways from Valparaiso to Santiago and Los Andes, a total line mileage of 144 miles.

Electric Motive Power for the Paulista Railway

A total of 16 electric locomotives, six for passenger and ten for freight service, were purchased in the United States for the Paulista Railway, Brazil. Two passenger and two freight locomotives were supplied by the Westinghouse Electric International Company, and the remainder of the locomotives by the General Electric Company. The freight locomotives are now in Brazil ready for service, and the passenger locomotives have been completed and shipped from the works of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.

Car Repair Contracts

THE MAINE CENTRAL is having repairs made to about 800 box cars at the shops of the Laconia Car Company, Laconia, N. H.

THE MICHIGAN CENTRAL has awarded a contract for the repair of 500, 40-ton underframe box cars and 250, 50-ton steel twin hopper cars to the Illinois Car & Equipment Company, Hammond, Ind.

THE CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS has awarded a contract for the repair of 500, 50-ton all-steel box cars to the American Car & Foundry Company, the work to be done at the Madison, Ill., plant.

THE ERIE has entered into a contract with the Greenville Steel Car Company, Greenville, Pa., for the repair of 1,000 steel coal cars of 50-ton capacity. This is in addition to the repairs on 1,000 cars previously let to the same company.

THE NEW YORK CENTRAL has awarded contracts for the repair of 500, 40-ton steel underframe box cars to the Streeter Car Company, Kankakee, Ill., to the Standard Steel Car Company, Pittsburgh, Pa., and to the Ryan Car Company, Chicago. It has also awarded contracts for the repair of 500, 50-ton steel hopper cars to the Buffalo Steel Car Company, Buffalo, N. Y., to the Detroit, Mich., plant of the American Car & Foundry Company, and to the Ryan Car Company; and for 250 cars of this type to the Steel Car Company, Euclid, Ohio; also for 500 box cars to the Koppel Industrial Car & Equipment Company, Koppel, Pa.

Unemployment Conference

The President's Conference on Unemployment, after creating a standing committee with authority to convene the full conference at any time and to continue its work through subcommittees during the continuance of the emergency, concluded its sessions at Washington on October 13. The conference adopted a general program of emergency measures outlining means of affording temporary relief during the coming winter and more fundamental methods for reviving business and preventing seasonal unemployment and depression in the future, as well as a number of committee reports in amplification of the general principles expressed.

Railway Fire Prevention Association

The eighth annual convention of the Railway Fire Prevention Association opened at Chicago, on October 18. The meeting was opened by President W. F. Hickey in the presence of about 150 members and guests and was addressed by Alfred H. Erickson, assistant corporation counsel of the city of Chicago, who represented the mayor of the city in welcoming the convention. The meeting was also addressed by J. E. McDonald, chief of fire prevention of the city of Chicago, who gave a short account of the history of fire prevention in Chicago and congratulated the railroad association in having taken so prominent an interest in fire prevention.

Open Saginaw Million Dollar Terminal

Pere Marquette officials and members of the Saginaw Board of Commerce formally opened the new million dollar terminal at Saginaw, Mich., on October 11. The dedication of the new buildings, followed by congratulatory speeches by members of the Saginaw Chamber of Commerce, marked the opening. The new work consists of a thirty-stall engine house, a machine shop, a power house having a 1,000-horse-power capacity, a 100-ft. turntable, a 500-ton coal dock, a cinder conveyor with electrically-operated ash handling equipment, two water tanks, a storehouse, and a general service building.

Bad Order Cars

On October 1 the Car Service Division of the American Railway Association reported 364,372 cars in need of repair, or 15.8 per cent of the cars on line.

Surplus Serviceable Cars

The Car Service Division of the American Railway Association reported a total of 201,153 surplus freight cars on September 23. This total, however, showed decreases of 28,733 and 29,450 cars during the weeks ended October 1 and October 8 when the totals were 172,420 and 142,970 cars, respectively.

Freight Car Loading

According to the weekly report of the Car Service Division of the American Railway Association, the total number of cars loaded with revenue freight during the week ended September 24 was 873,305, an increase of 19,543 over the previous week. This was the largest loading for any week since November 20, 1920, but was 134,804 cars below the total for the corresponding week of 1920.

During the week ended October 1, a total of 901,078 cars were loaded, 27,773 cars less than were reported for the preceding week.

There was a reduction of over 5,000 cars in the freight car loading for the week ended October 8 as compared with the previous week. The total was 895,740 as compared with 1,011,666 in the corresponding week of 1920 and 982,171 in 1919.

Shop Construction

CHICAGO, BURLINGTON & QUINCY.—This company has awarded a contract for the construction of a ten-stall brick roundhouse and a 100-ft. turntable at Centralia, Ill., to Jos. E. Nelson & Sons, Chicago.

ATCHISON, TOPEKA & SANTA FE.—This company will construct several extensions to its machine shops at San Bernardino, Cal., at an estimated cost of $224,000. It will also install a boiler washing plant in connection with its shops at this place. The same company will construct a blow-off line in the roundhouse at Cleburn, Tex., and a similar one in its roundhouse at Temple, Tex., to cost about $11,000 each; a dike for protection against floods will be constructed in the rear of its engine house at La Junta, Colo.; estimated to cost about $17,000; and a similar protection against floods will be constructed at Canadian, Tex., to cost about $25,000.

Imprisonment for Falsification of Car-Repair Bills

Theodore W. Krein, general manager of the Muscatine, Burlington & Southern, pleaded guilty to an indictment charging him with falsification of car repair records and accounts in violation of the Interstate Commerce Act, in the United States District Court at Davenport, Iowa, on October 6 and was sentenced to one year and a day in the federal penitentiary, and fined $3,000. The railroad company and Krein were charged with falsifying the company's records to show that the railroad had made repairs to cars of other railroads when no such repairs were actually made. Fraudulent bills based upon these records were rendered against other railroads and in this manner approximately $30,000 was collected from other carriers during the year 1919 for car repairs which were not made. Nearly all of this amount was collected from railroads operating under federal control and therefore was a fraud upon the government; the Muscatine,

Burlington & Southern was not under federal control during that period. The prosecution followed an investigation by the Interstate Commerce Commission.

This road is 54 miles long, extending from Muscatine, Iowa, south to Burlington. It has six locomotives and 22 freight and passenger cars.

Extension of Time on Interchange Rule Three

The mechanical division of the American Railway Association, in circular No. V-216, announces the extension of the effective date of section f of Rule 3 of the interchange rules, to January 1, 1922. As it now stands this section of the rule requires that after October 1, 1921, no cars carrying products which require the use of salt with ice, and equipped with brine tanks, shall be accepted in interchange unless provided with a suitable device for retaining the brine between icing stations. The extension of time has been made in accordance with the recommendation of the Committee on Car Construction, in view of the fact that not all refrigerator cars with brine tanks have yet been equipped to meet the requirements of the rule.

Activity of the Krupp Works

According to press dispatches, W. T. Daugherty, trade commissioner at Berlin, has made the following report concerning the activity of the Krupp Works:

"In June, 1921, the combined Krupp plants had about 99,000 employees, working eight hours a day, while the production had passed from the pre-war mass manufacturing stage to refining production. Today, instead of manufacturing parts for locomotives, for instance, Krupp is manufacturing the locomotive entire.

"It is pertinent to note, in this connection, that among other finished goods of varied description, Krupp's Essen plant is now turning out a locomotive and a train of eight steel 15-ton freight cars for each working day of the year.

"Production is organized vertically, Krupp products being finished refined, from the crude raw materials, while all intermediate stages between the raw material and finished production are combined in this enterprise. A selling organization exists in addition."

The Oldest Illinois Central Locomotive

The Mississippi, the first engine ever used on the Illinois Central system, was exhibited during the month of September at the Indiana State Fair, Indianapolis, Ind.; the Kentucky State Fair, Louisville, Ky., and the Interstate Fair at Sioux City, Iowa. It was also shown at the National Implement & Vehicle Show at Peoria, Ill., until October 8.

This engine was built at Natchez, Miss., in 1834, the parts having been imported from England to be assembled there. Its cylinders are 9½ in. by 16 in., and it weighs 14,000 lb. It is said that the entire cost of the engine was less than $2,000. The newest locomotive bought by the Illinois Central this year weighs 382,000 lb., has cylinders 30 in. by 32 in., and its cost was $88,819.

The Mississippi was first used on a line between Natchez and Foster, Miss. (later acquired by the Illinois Central), in 1836, 1837 and 1838. There are no records between 1838 and 1873, but in 1873 and 1874 the Mississippi was in service on a line between Warrenton, Miss., and Vicksburg. In 1874, an engineer, John Rogers, put the Mississippi on a side track to rest for the night, but forgot to close the throttle, with the result that the engine ran into a deep mud bank, where it lay until 1880. From 1880 to 1890, it was used as a switching engine in a gravel pit at Brookhaven, Miss. The engine was given a general overhauling in 1892 and was exhibited in the Transportation Building of the World's Columbian Exposition at Chicago in 1893. It traveled from McComb, Miss., to Chicago under its own power. It was also on exhibition at the St. Louis World's Fair in 1904.

Proposed Wage Cut on Scottish Railways

C. T. Cramp, industrial secretary of the National Union of Railwaymen, addressing railway employees at Edinburgh, said that the Scottish railways have proposed the abolition of the increases in wages granted by the National Wages Board in June (averaging $1.25 per week), and of the special payment for night duty; also that minors shall not receive the pay of adults until they reach the age of 21, according to the Times (London). There are also proposals to abolish the eight-hour day, and substitute 10 hours in many classes, with a "spread" in some grades of 12 hours.

The companies have agreed, he continued, on condition that the employees give up the National Board's award on wages, that they will withdraw their other proposals, and in the event of this offer being rejected, they will go, first to the Central, and afterwards, in the event of disagreement, to the National Wages Board, with the whole of their original proposals. There could be no strike until one month after the National Wages Board has issued its award.

The meeting passed a resolution, expressing the opinion that the proposals were entirely unacceptable, and recording dissatisfaction at the financial statement made by the companies as the reason for proposed changes. The meeting asked for information regarding the allocation of the $25,000,000 set aside by the government for the relief of companies having a deficit because of the conditions of the national settlement, and urged on the union executive the desirability of preserving the principle of national negotiations.

Austria Plans Extensive Electrification

On July 23, 1920, a bill passed the Austrian National Assembly which authorized the electrification within a period of seven years of 405 miles out of the 2,780 miles of railway lines administered by the Austrian government and further contemplates the electrification of 706 miles more within a second period of seven years. If this is done, 1,111 miles or 40 per cent of the Austrian State Railway will have been electrified. The remaining lines by reason of the peculiar traffic will probably not be electrified at all.

So far 27 locomotives—15 passenger and 12 freight—have been ordered from Austrian factories (Brown Boveri, A.E.G., Union and Siemens-Schuckert). This is about one-eighth of the locomotives needed for operation on all lines to be electrified. The passenger locomotives will be of the 2-6-6-2 type and the 2-6-2 type. The 2-6-6-2 engines will operate at a speed of 31 m.p.h. The capacity of these locomotives is about 25 per cent greater than that of the five driving axle steam locomotives now used. They have a rated horsepower of 1,850 at 30 m.p.h. and an overload capacity of 3,000 hp.

The freight locomotives will be of the 0-10-0 type with a rated capacity of 1,000 hp. at an average speed of 18.5 m.p.h. and an overload capacity of 2,000 hp. The cars to be used in the trains operated by electric locomotives will be the same as used for steam operation.

Argentina Buys Freight Cars

According to Commerce Reports, word has been received from Commercial Attaché Edward F. Feely, of Buenos Aires, reporting that the lowest bids offered by each of the following nationalities, as covering railway cars, under tender at Buenos Aires, were as follows:

	Gold pesos per car*
Lowest German bid	3,484
Lowest American bid	4,580
Lowest Belgian bid	5,000
Lowest British bid	5,900

*Gold peso = $.96 at par.

Further word has been received which indicates that the authorities of Buenos Aires have decided to increase the number of cars which they intend to purchase at this time. The original bids covered 70 of the above cars, but at the time of placing the order it was decided to increase the quantity to 100 cars, and the business has been awarded to a firm in Breslau, Germany, under the name of Linke Hoeman, the price being 3,290 Argentine gold pesos each.

This transaction is peculiarly interesting as showing the position of American manufacturers compared with Belgian and British makers who are obviously not in a favorable position with regard to such equipment, although the design of the cars used on the railways of Argentina resembles European practice more closely than the American designs.

This incident also raises the question as to whether the German manufacturers will be able to make prompt delivery of materials of satisfactory quality. Recent experience in other foreign markets suggests that serious difficulty in this connection may result.

American Railway Association

The regular meeting of the American Railway Association will be held at The Waldorf-Astoria, New York City, on Wednesday, November 16. Reports of divisions of the associations are expected to be presented as follows:

Division I.—Operating; Freight Station Section; Medical and Surgical Section; Protective Section; Safety Section; Telegraph and Telephone Section.

Division II.—Transportation.

Division III.—Traffic.

Division IV.—Engineering, Construction and Maintenance Section; Electrical Section; Signal Section.

Division V.—Mechanical; Equipment Painting Section.

Division VI.—Purchases and Stores.

Division VII.—Freight Claims; Car Service Division; Joint Committee on Fuel Conservation; Joint Committee on Automatic Train Control; Conference Committee on Grain.

Copies of the reports will be forwarded to members in advance of the meeting.

Machine Tool Builders' Convention

The twentieth annual convention of the National Machine Tool Builders' Association was held October 18, 19 and 20 in the Hotel Astor, New York. A considerable proportion of the membership was in attendance at the opening session when H. Tuechter, president of the association, read his opening address. The president's address was of considerable length, devoted to many details of the work of the association, and yet presented in such a forceful way that it was listened to with keen attention by all those present. The possibilities in the way of standardization of tools, improved standard methods of cost accounting and the value of the statistical service being developed by E. F. Du Brul, general manager of the association, were pointed out. It was proposed to make this statistical service a business barometer to guide the members of the association in the conduct of their business. The president's address was followed in the afternoon by addresses by Charles L. Underhill, congressman from Massachusetts, on "How Present Political Policies Affect Business"; Professor Jordan of New York University on "Business Cycles" and C. L. Cameron and E. F. Du Brul on "What Things Should Machine Tool Builders Do and What Should They Avoid at Various Stages of the Cycle." The second day of the convention was devoted to committee meetings and the third, to addresses of general interest and value followed by an executive session which considered unfinished business and elected officers for the ensuing year. Officers of the association for the year 1921 were re-elected for 1922, the only change being in the election of Howard W. Dunbar, Norton Company, Worcester, Mass., as secretary.

Railway Wages in Great Britain

The average weekly earnings of railway employees in Great Britain prior to the war in 1914 was 25 shillings a week (about $6 at par exchange). Many increases were granted as living costs rose—at first by granting bonuses and later by making these bonuses a part of the regular weekly wage. By April 1919, the average weekly rate had been increased to 63 shillings (approximately $15.75 at par exchange). At this time it was agreed to add one shilling (approximately 25 cents) to the rate for every increase of 5 points in the index of the cost of living and a similar deduction for every decrease of 5 points. Permanent standards or "stop" rates were fixed at a point approximately 100 per cent above pre-war wages. Beyond this "stop" wages may not fall. The average "stop" is 53 shillings (approximately $13.25).

Under the sliding scale of wages, with increases of one shilling for each increase of 5 points in the cost of living index, wages were increased $2 a week above the 1919 rate. Since living costs have dropped, wage rates under the sliding scale have been decreased $2.25 a week. Generally speaking, therefore, wages are now about $15 a week, or 150 per cent above the pre-war level.

The total wage bill of the British railways in 1920 amounted to $798,106,000 as compared with $228,725,000 in 1913, or an increase of 250 per cent. Fifty-two cents of every dollar spent by the railroads in 1920 went for wages, as compared with 35 cents in 1913. The *Railway Mechanical Engineer* is indebted to the Bureau of Railway Economics for the data herewith presented.

Locomotive Orders

The Bahia Railways of Brazil have ordered 17 locomotives from the Baldwin Locomotive Works.

The Chicago, Rock Island & Pacific has ordered 14 Mikado type locomotives from the American Locomotive Company.

Delaware, Lackawanna & Western.—The Elvin Mechanical Stoker Company, New York, has been given an order by the Delaware, Lackawanna & Western for 49 Elvin mechanical stokers for installation on its Mikado type locomotives.

The Argentine State Railways have ordered 50 Mountain type and 25 Pacific type locomotives from the Baldwin Locomotive Works. These locomotives will all be of meter gage and will be equipped to use either wood or oil for fuel. The Mountain type locomotives are to be used for mixed service and will have 19 by 24-in. cylinders, 50-in. driving wheels and a total weight in working order of 170,000 lb. The Pacific type will be used for passenger service and will have 20 by 28-in. cylinder, 57-in. driving wheels and a total weight in working order of 173,000 lb. A sample Mountain type locomotive was built by the Baldwin Works about two months ago for the same roads.

Freight Car Orders

The Delaware, Lackawanna & Western has ordered 500 steel hopper cars of 50-ton capacity from the Cambria Steel Company; 500 from the American Car & Foundry Company and 500 from the Standard Steel Car Company.

The Baltimore & Ohio has ordered 500 steel hopper car bodies from the Cambria Steel Company, 500 box car bodies from the American Car & Foundry Company, 500 box and 500 steel hopper car bodies from the Standard Steel Car Company.

The Argentine State Railways, according to a press dispatch from Buenos Aires, dated October 18, have entered into a contract, subject to the approval of President Yrigoyen, with the Middletown Car Company for the delivery of 2,000 freight cars. Payment for the equipment is to be made in Argentine 6 per cent treasury notes maturing in five years.

The Chilean State Railways have ordered 100 general service gondola cars of 50-ton capacity, from the Pressed Steel Car Company; 200 box cars from the American Car & Foundry Company, and 100 flat cars from Belgian builders.

Welding Equipment Investment Nets 300 Per Cent

Practical application of the electric arc welding process was the subject of a paper read by E. Wanamaker, electrical engineer of the Rock Island, at a meeting of the Metropolitan Section of the American Welding Society, on September 20, at the Engineering Societies' Building, New York, N. Y. The paper dealt principally with the equipment, materials and skill required for successful welding. Mr. Wanamaker spoke particularly of the manner in which results are obtained on the Rock Island. A book of looseleaf specifications is sent to welders and welding foremen, which explains what can be welded, how the work can best be done, how to test the quality of a weld, etc., giving the welder sufficient information to work intelligently, provided he understands the fundamental principles, and keeping him up to date on all new practices. New sheets, superseding those in the book, are sent out as new methods are developed. Cleanliness and impressing the welder with his responsibility, said Mr. Wanamaker, are big factors in getting and maintaining good results.

It has been shown that an investment of $150,000 in welding equipment on the Rock Island has in a few years saved three times its cost.

After the practice of welding locomotive tires was established, no new tires were purchased for a period of three years, and the number now bought is only about one-third of the former average.

Operating Improvements on the Paris, Lyons & Mediterranean

The Paris, Lyons & Mediterranean is the longest privately owned railway in Europe, says the Railway Gazette (London), in presenting some interesting information concerning that road. At the end of last year it possessed a total stock of 4,662 loco-

motives (including those for narrow-gage lines) as compared with 3,571 at the beginning of 1914. Of these, 498 engines were American and 177 German, and during the year there were ordered 80 Pacifics, 120 Mikados and 50 ten-coupled locomotives. An interesting sidelight is thrown on the effects of the eight-hour day by the fact that it became necessary to open four new locomotive shops (a fifth will shortly be opened), and to enlarge six existing ones.

The company has submitted to the Ministry of Public Works a program for the electrification of some 1,800 miles of line, to be operated by hydro-electric power, which will largely be obtained from the Rhone. It is hoped to make a beginning on the Culoz-Modane line, which has very severe gradients and handles a heavy traffic. Like other French railways, the Paris, Lyons & Mediterranean has found it advantageous to make its own arrangements for the maritime transport of locomotive coal, and by the end of the current year it hopes to have received delivery of a new fleet of 14 vessels with an aggregate capacity of 100,000 tons, in addition to the seven already acquired.

Another of its activities has been the establishment of a refrigerator car and warehouse company, in co-operation with the Northern and Eastern Railways, which has leased the 550 refrigerator cars fitted up by the Paris, Lyons & Mediterranean for war service, as well as a number left behind by the American Army. Another American legacy, it may be recalled, was the train dispatching system. This has been experimented with between Dijon, Chalon-sur-Saone and Lyons, and the results have been so satisfactory that it is proposed to adopt the system on a much larger scale.

Training of Apprentices on the Victorian Railways.

The State Railways of Victoria, Australia, have in operation a comprehensive system of training apprentices, according to the Engineer (London). To quote: "Under these regulations it is possible to obtain a very good class of youths who, after a training in technical and practical work, are well prepared to become first class tradesmen, and eventually foremen. In some cases, when the ability of an apprentice is outstanding, he may become a member of the professional staff, and in course of time may be appointed head of his branch, as has occurred quite recently, when one, who joined the service as an apprentice 15 years ago, was appointed chief electrical engineer of the Victoria railways."

Bulletins are posted in various places announcing vacancies in the occupations and applicants apply in writing. When an apprentice is employed he is placed on probation for six months at the end of which time his fitness has been determined. The period of apprenticeship is five years, during which time the apprentice performs duties of the trade he is studying at one of the shops of the system. At the same time he must attend classes in designated trade schools where his tuition is paid. Apprentices are, as a general rule, paid 75 cents a day for the first year, 93 cents the second year, $1.31 the third year, $1.68 the fourth year and $2.25 the fifth year.

The school work required of all first year apprentices is the same, viz.: elementary science, arithmetic and geometry. In the second year the courses are mathematics, drawing and applied mechanics. Different courses are provided the third year for various crafts. Some of them are algebra, solid geometry, engineering, drawing, electricity, steam and design. Various prizes are offered by the company for good school work and of each third year class one student is chosen to study engineering. This student devotes the next two years, full time, to this work and receives $650 a year in lieu of wages besides his free tuition. If he completes the course satisfactorily he is given the position of engineering assistant at an entrance salary of $1,125 per annum.

Continuous Brakes in Germany

"It is well known," says the Railway Gazette (London), "that Germany is one of the countries where prior to the war the Westinghouse air-pressure brake was in general use. During the war conditions suffered a change, inasmuch as the Prussian authorities in their triumphant state of mind decided to introduce something different in detail from the Westinghouse air brake, in order to avoid foreign influence in this line of business and with a view to eliminating as far as possible foreign enterprise in the German territories. To find possible opportunities for alterations in the Westinghouse brake system the patents of this company were carefully studied, with the result that the fundamental idea in one of these patents—which happened to have just expired—was selected and developed into a so-called differential brake by introducing a very complicated new kind of valve.

"Letting alone for the present its technical features, it must be said that the innovation was effected by the Knorr Company in direct co-operation with the railway authorities themselves and their high officials; in fact, the name of the so-called new brake system includes the name of one of these officials. The Prussian government then decided to replace the Westinghouse brake by this newly-prepared system, pushing ahead the introduction of the so-called Kunze-Knorr brake with the greatest energy. Thus a fact was established to compel their enemies (after Germany emerged victorious from the war) to adopt the same kind of innovations that they themselves were going to introduce. The government went ahead so precipitately that as early as 1917 the means necessary to fit up the entire rolling-stock of their goods wagons (i. e. freight cars) with this new brake were afforded by the Prussian Diet. The execution of the program was taken up without delay. As a second step the Prussian government went on to eliminate Westinghouse, assigning to the Knorr company practically the whole of the repairs on cars equipped with the Westinghouse brake proper, the brake parts being provided from the stores of the Knorr company as 'Knorr-West brake parts,' as they were called, and at prices which are fixed in an official catalogue.

"Both England and America think that these peculiar ways are neither in accordance with the aims of the International Commission, which in itself has been shunned by the Prussian authorities, nor with certain stipulations of the Peace Treaty. It would be interesting if the German Government would explain why, in spite of its heavy financial obligations, it is spending such enormous sums for new equipment, which expenditure could not be afforded even by the victorious parties for similar purposes."

The Spanish Railway Problem

The railway problem in Spain is somewhat similar to that in this and other countries, according to Commerce Reports. Operating costs have risen to the point where freight and passenger rates must be increased or some corresponding form of relief discovered if the roads are to continue to operate and escape bankruptcy. The public is not in favor of an increase in rates.

Nor are the railways giving satisfactory service. They are built on three different gages, approximately 5 ft. 6 in., 4 ft. 8½ in., and 3 ft. 4 in., respectively, and as they all radiate from Madrid, they do not always meet the economic needs of the country.

Among other efforts the government is making to meet the present situation, they have decided to encourage the construction of locomotives and cars in Spain, and have arranged that when bids are called, the business shall be awarded to manufacturers in Spain, provided their price does not exceed foreign offers by more than 10 per cent. In addition to this preference they have increased the duty on imported locomotives and cars, and Commercial Attaché Cunningham, of Madrid, reports that further increases are to be expected. Moreover, Spanish industrial plants, on complying with certain formalities, are allowed a reduction in the import duties charged on foreign manufactured materials needed in the construction of locomotives and railway cars.

As a result of the government's activities, the production in Spain of railway equipment of the class mentioned has been stimulated, and Commercial Attaché Cunningham reports that in the first six months of this year orders have been placed for the construction of 5,000 European pattern railway, freight, passenger, and baggage cars with 16 different Spanish plants in different parts of the country.

Correspondingly, the Maquinista Terrestre y Maritima has received an order for 50 locomotives, of which five have been delivered, and as these are larger and more powerful than other engines previously in operation, the better service resulting is adding to the prestige of these builders and to the disadvantage of the German, Belgian, French, Italian and British manufac-

turers who have previously supplied most of the locomotives operated in Spain.

Other companies plan to build locomotives in Spain, and, in addition to the inducement mentioned, there are other ways to show them preference. The Sociedad Espanola de Construcciones Babcock and Wilcox has been extended an exemption from the payment of imports and stamp taxes covering an issue of 39,200 shares of 500 pesetas (1 peseta = $.193 at par) each, and also a 60 per cent reduction during five years from the amounts that would ordinarily be due under the utilities tax. These special benefits are understood to have been accorded to assist this company in the production of locomotives and parts and similar products. Recently the Spanish government established an industrial bank with a capital of 150,000,000 pesetas, which is reserved for loans to purely Spanish enterprises.

Meetings and Conventions

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. C. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Regular meeting 2d Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Annual dinner Thursday evening, November 10, at 7:30 p. m. Hon. Charles F. Moore, the Virginia judge, will be toastmaster. A prominent speaker will be present. Dancing and other entertainments.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting November 8, Hotel Sinton, Cincinnati. Annual banquet and election of officers. Musical entertainment.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting November 8. Paper on "Activities of the American Railway Association," will be presented by Mr. Aishton, president, American Railway Association.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting November 18. Paper to be presented on "Passing the Buck—Not the Dividend," by Howard Elliott, American Sugar Refining Company.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting November 10, at Hotel Oakland, Oakland, Cal. Paper on "Supervision of Transportation" will be presented by J. H. Leary, superintendent, Western Pacific, and T. F. Allen, supervisor of transportation, Northwestern Pacific. General discussion (invited) by supervisors of transportation, superintendents and trainmasters.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Americus Club House, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

J. C. Nolan, superintendent of the Texas division of the Gulf Coast Lines, with headquarters at Kingsville, Tex., has been appointed mechanical superintendent, with the same headquarters, succeeding J. L. Lavallee, resigned. J. E. Callahan, superintendent of the Louisiana division, with headquarters at De Quincy, La., has succeeded Mr. Nolan as superintendent of the Texas division, and G. C. Kennedy has succeeded Mr. Callahan as superintendent of the Louisiana division.

F. S. Wilcoxen has been appointed fuel supervisor of the Chicago Great Western, with headquarters at Chicago.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Lee Pearson has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe at Needles, Cal.

SHOP AND ENGINEHOUSE

E. P. Eich has been appointed day roundhouse foreman and John Wren night roundhouse foreman of the Chicago, Rock Island & Pacific at Kansas City, Kans.

Harvey Grange has been appointed general foreman of the Chicago & Northwestern, with headquarters at Clinton, Iowa.

H. W. Sasser has been appointed shop superintendent of the Erie at Galion, Ohio, succeeding G. T. Depue.

W. Wilcox has been appointed roundhouse foreman of the Illinois Central at Jackson, Tenn., succeeding C. B. Thompson, transferred to Birmingham, Ala.

PURCHASING AND STORES

F. J. Talbot has been appointed superintendent of stores of the New York and Hornell regions of the Erie with headquarters at Hornell, N. Y., and J. H. Sweeney has been appointed to a similar position for the Ohio and Chicago regions, with headquarters at Meadville, Pa.

J. D. McCarthy, who has been appointed purchasing agent of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., succeeding W. E. Manchester, was born at Chicago, Ill., on August 26, 1881. He entered railroad service in 1899 with the Chicago Great Western, and served successively until 1904, as roadmaster's clerk, chief clerk to the division engineer and division storekeeper. From 1904 to 1906 he served in the accounting department of the Chicago, Rock Island & Pacific. In 1906 Mr. McCarthy entered the service of the Chicago & North Western and through various promotions became assistant purchasing agent of that company. He was serving in this capacity at the time of his recent appointment.

J. D. McCarthy

A. J. Mello has been appointed superintendent of commissary stores of the Southern Pacific, with headquarters at San Francisco, Cal.

A. Singleton has been appointed purchasing agent and general storekeeper of the Hocking Valley, with headquarters at Columbus, Ohio, succeeding J. R. Mueller, purchasing agent, and Leon Stiers, general storekeeper, assigned to other duties.

SUPPLY TRADE NOTES

H. E. Billau, a field representative of the Sherwin-Williams Company for the past 35 years, died at Fremont, Ohio, on September 19, 1921.

George A. Barden has been appointed railway sales representative with headquarters at 4631 York road, Philadelphia, Pa., of the Lowe Brothers Company, Dayton, Ohio.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., will establish a branch in charge of V. D. Clark, at 316 Thirteenth street, Huntington, W. Va.

James A. Slater, manager of sales of the National Malleable Castings Company, at Chicago, has been appointed assistant sales manager with headquarters at the company's general offices in Cleveland, Ohio, succeeding J. H. Redhead.

Morris B. Brewster has formed a corporation under the name of Morris B. Brewster, Inc., with headquarters at 332 South Michigan boulevard, Chicago, to handle metallic packing, mechanical devices, such as Edson diaphragm pumps and similar articles. Associated with Mr. Brewster in the new company are W. B. Leach, J. G. Platt and F. M. Weymouth of Boston.

A. Clarke Moore, formerly assistant to the president of the Globe Seamless Tube Company, has been appointed vice-president of the Chicago Railway Equipment Company, succeeding the late C. Haines Williams, deceased. Mr. Moore has been actively engaged in the railway supply business for the past 22 years. In July, 1899, he entered the service of the Safety Car Heating & Lighting Company, which company he served until November, 1919, with the exception of a year and one-half in 1906 and 1907, when he was with the Western Steel Car & Foundry Company and McCord & Company. During this time he filled various positions, serving for the last six years as vice-president, and for the two years prior to that time as general manager. During the war Mr. Moore was commissioned a major in the Air Service department, with headquarters at New York, having charge of the production of air craft in the eastern territory. In November, 1919, he became associated with the Globe Seamless Steel Tube Company of Chicago as assistant to the president, from which position he resigned in August, 1921. As vice-president of the Chicago Railway Equipment Company, Mr. Moore will have general supervision of the manufacturing and selling departments.

A. C. Moore

The Toronto, Ontario, office of the Independent Pneumatic Tool Company, Chicago, has been removed from 32 Front street West, to larger quarters at 163 Dufferin street, Toronto. This office will remain in charge of William McCrae.

The Superior Supply Company, Chicago, has been appointed the direct factory representative of the Novo Engine Company, Lansing, Mich., and will handle the sale of the Novo line of portable power driven outfits, including pumps, hoists, compressors, saw rigs, etc.

G. R. Watson, formerly electrical supervisor for the Pullman Company at Chicago and later representative of the Crouse-Hines Company at Cincinnati, Ohio, has been appointed general sales manager of the Wadsworth Electric Manufacturing Company, Inc., with headquarters at Covington, Ky.

Andrew G. Young, traffic manager of the American Sheet & Tin Plate Company, died at Cleveland, Ohio, on September 29. Prior to his appointment, 20 years ago, to the position which he held at the time of his death, Mr. Young was serving as general freight agent on the Lake Erie & Western.

C. J. Burkholder, who has been serving the Franklin Railway Supply Company, New York, as special engineer in the western territory, is now supervising service for the same company on all railroads. A sketch of Mr. Burkholder's career was published in the August issue of the *Railway Mechanical Engineer.*

Sidney G. Down has been appointed to the newly created office of general sales manager of the Westinghouse Air Brake Company, with headquarters at Wilmerding, Pa. He was formerly Pacific District Manager of the Westinghouse Air Brake interests and president of the Westinghouse Pacific Coast Brake Company. Mr. Down served as general air brake inspector and instructor on the Michigan Central until 1901, and then joined the Westinghouse Air Brake organization. He was for several years instructor on the company's instruction car and later was appointed mechanical expert with headquarters in Chicago. In 1910 he was appointed district engineer and transferred to San Francisco and shortly afterward he was appointed Pacific district manager. He was largely responsible for the organization of the Westinghouse Pacific Coast Brake Company in California, and when it was formed, became vice-president and later president of that company. Two years ago he made an extensive tour of the Far East and established various commercial activities which have resulted in an increased business for the Air Brake Company from the Orient.

S. G. Down

T. N. Gilmore, who for the past sixteen years has been associated with Westinghouse, Church, Kerr & Co., engineers and contractors, has opened offices as a consulting engineer at 136 Liberty street, New York. Mr. Gilmore was in charge of railroad shop and engine terminal work for Westinghouse, Church, Kerr & Co., and was for several years a director and vice-president and chief engineer of the company in charge of all engineering and construction. Mr. Gilmore received his early training in steam railroad work. Prior to the World's Fair at St. Louis in 1904, he went with the St. Louis Terminal, where he was in charge of the mechanical and car departments and in addition planned the power houses, locomotive shops and engine terminal facilities constructed to handle the traffic for the fair. Mr. Gilmore is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers and the Structural Engineers Association of Illinois.

T. N. Gilmore

H. O. Davidson has been appointed to take entire charge of the Prudential Sectional Building Department of the Blaw-

Knox Company, with headquarters at Baltimore, Md., where he will also serve as general manager of the C. D. Pruden plant, of the Blaw-Knox Company. At the time of his appointment Mr. Davidson was general manager of the Hydraulic Steelcraft Company.

O. B. Frink, assistant principal engineer of the Hall Switch & Signal Company, Garwood, N. J., has been appointed representative of the Waterbury Battery Company, Waterbury, Conn., with office at 30 Church street, New York City, and S. J. Hough, field service engineer at New York, of the Waterbury Battery Company, has been appointed western representative with office at 1361 Peoples Gas building, Chicago, Ill.

Charles B. Seger, president of the United States Rubber Company, New York, has been elected also chairman of the board, succeeding as chairman Col. Samuel P. Colt, deceased. Mr. Seger was born on August 29, 1867, at New Orleans, La., and was for many years in railway service, having begun work as an office boy with Morgan's Louisiana & Texas Railroad & Steamship Company, now a part of the Southern Pacific. He subsequenlty served as a clerk until 1887, when he was appointed steamship auditor. He was then auditor and later clerk to the chief auditor until 1893, when he was appointed auditor and secretary of the Galveston, Harrisburg & San Antonio, the Texas & New Orleans and the Direct Navigation Company. In January, 1900, he was appointed also auditor and secretary of the Galveston, Houston & Northern. On November 1, 1904, he was appointed auditor of the Southern Pacific—Pacific system, with office at San Francisco, Cal., and six years later became general auditor of the Southern Pacific-Union Pacific systems, later serving as deputy controller until the separation by the courts of the Southern and Union Pacific systems in 1913, when Mr. Seger became vice-president and controller of the Union Pacific and from March to December, 1918, served as acting chairman of the executive committee and as president. Since January 1, 1919, he has been president of the United States Rubber Company and now becomes also chairman of the board, as above noted.


C. B. Seger

T. E. Cocker has been appointed district manager of the Chain Belt Company, in the Buffalo territory, with headquarters at Buffalo, N. Y. Mr. Cocker is a graduate of the Rensselaer Polytechnic Institute, class of 1907, civil engineering. From 1907 to 1917 he served in the engineering department of the New York Central at Buffalo, holding the position of assistant engineer at the time he left the railroad. For the past five years he has been handling elevating and conveying equipment.

The Central Steel Company, the National Pressed Steel Company and the Massillon Rolling Mill Company, all of Massillon, Ohio, have been brought together in a merger just completed. The new corporation takes the name of the Central Steel Company and the following officers have been elected: Chairman of the board of directors and president, R. E. Bebb; first vice-president, F. J. Griffiths; second vice-president, C. C. Chase; third vice-president, H. M. Naugle; secretary and treasurer, C. E. Stuart. The reorganized company has complete modern equipment and facilities for producing all kinds of commercial alloy steels, hot and cold rolled sheets, hot rolled strip steel and light structural steel.

J. H. Redhead, assistant manager of sales of the National Malleable Castings Company, has resigned to become manager of the Reliance Company, Cleveland, Ohio, which firm has recently been organized by the Reliance Trust Company in conjunction with its affiliated companies, the Reliance Savings and Loan Company and the Reliance Securities Company. These companies are engaged in various banking and investment activities. Mr. Redhead was born in Cleveland in 1880 and was graduated from Central High School of that city in 1899. He began his career as an office boy with the National Malleable Castings Company and worked through various branches of the accounting department until 15 years ago when he entered the sales department. He was lately appointed assistant manager of that department. For several years Mr. Redhead has been in charge of the advertising carried on by the American Malleable Castings Association.

F. H. Sauter, formerly associate editor of the Locomotive Dictionary, has accepted a position with Gibbs & Hill, consulting engineers, Pennsylvania Station, New York City. His work with this firm will have to do with the development of railway electrification. Mr. Sauter was born in Schenectady, N. Y., February 1, 1877, and was educated in the public schools of Schenectady. In 1894, he entered the General Electric Company's factory and completed a mechanical engineering course under private instruction during the factory employment period. In January, 1900, he entered the General Electric Company's drafting department and in 1903 he worked with the Schenectady Railway Company as assistant master mechanic. In the fall of 1904, he served with the Peckham Manufacturing Company, Princeton, N. Y., as electric truck designer. In 1905, he entered the services of the American Locomotive Company, Schenectady, N. Y., and while with this company he held positions as draftsman and designer of steam locomotives, electric trucks, and electric locomotives, and as electric locomotive and truck estimating engineer. In December, 1917, he entered the employ of the Simmons-Boardman Publishing Company as associate editor of the Locomotive Dictionary. He went to the Crown, Cork & Seal Company, Baltimore, in May, 1918, and in July of that year was made supervisor of Trade Machinery and in April, 1920, assistant manager of the machine erecting department. The duties of this position included adjustment of machine complaints and personal visitation of the trade in the entire territory east of the Mississippi and some of the Western states.


F. H. Sauter

George R. Henderson, formerly consulting engineer of the Baldwin Locomotive Works, died on October 19, at Media, Pa. He was born on January 14, 1861, at Philadelphia, Pa., and graduated from Lauderback Academy, Philadelphia, in 1876. Two years later he began railway work serving consecutively to 1887, as apprentice, draftsman and assistant chief draftsman of the Pennsylvania Railroad. He was then to March, 1899, with the Norfolk & Western as assistant superintendent of the Roanoke shop and mechanical engineer. From March to July, 1899, he was with the Schenectady Locomotive Works, and from July of that year to June, 1901, served as assistant superintendent of motive power and machinery of the Chicago & North Western. He was then assistant superintendent of machinery and superintendent of motive power of the Atchison, Topeka & Santa Fe until August, 1903. The following year he became a consulting mechanical engineer at New York and in 1910 went to Brazil, serving for two years on the railways of Brazil. He then returned to the United States to become consulting engineer of the Baldwin Locomotive Works. During the war Mr. Henderson was consulting engineer to the Federal Fuel Administration in the Philadelphia district. He was well known as the author of books on locomotive operation and was a frequent contributor to the railway technical press.

TRADE PUBLICATIONS

Reclaiming Tools.—Illustrations, prices and instructions for figuring prices are contained in a 16-page catalogue which the Master Tool Company, Cleveland, Ohio, has recently issued presenting its line of reclaiming portable pneumatic tools.

Reclaiming Portable Pneumatic Tools.—The Master Tool Company, Cleveland, Ohio, has recently issued a 16-page illustrated catalogue and price list presenting its line of reclaiming portable pneumatic tools, their parts, and special tools, also instructions for figuring prices.

Tube Welding Machinery and Fabricating Equipment.—An illustrated bulletin listing a complete line of machinery for producing welded tubing from commercial steel sheets, or rolled strip stock, and briefly describing the procedure has been recently issued by the Davis-Bournonville Company, Jersey City, N. J.

Weight Cards.—The American Sheet & Tin Plate Company, Pittsburgh, Pa., has issued a new and revised set of weight cards covering black sheets, galvanized sheets, and formed products. These cards are 14 in. by 20 in. in size, are clearly printed and are of particular value to all buyers and users of sheet steel.

Metal Spraying.—The Schoop Metal Spraying Process, a means by which metallic coatings of any kind may be sprayed onto any surface, is fully described and illustrated in an interesting booklet of 16 pages, recently issued by the Metals Coating Company of America, Philadelphia, Pa.

Belting.—A summary of efficiency tests on various types of belting and two interesting charts showing slack of belt at point of slip-off and comparative efficiencies of various types of belts, as well as a price list of Lion Paw belting, are included in a 10-page booklet entitled "Cutting the Unreckoned Costs," recently issued by R. D. Skinner & Co., New York.

Spray-Painting.—The De Vilbiss Manufacturing Company, Toledo, Ohio, has recently issued an interesting folder describing its portable spray-painting system for spray-painting houses, building interiors and exteriors, railway equipment, bridges, ships and all kinds of large or stationary work. Clear-cut illustrations of the various outfits are shown, as well as photographs illustrating the performance and adaptability of the De Vilbiss equipment.

Power Pipe Machines.—Valuable data and information regarding the care and use of dies for threading pipe, as well as a very interesting illustrated story of business and pleasure in which the pipe machine is compared to the automobile, are presented in a 54-page booklet entitled "Don't Let it Happen to You," issued by the Williams Tool Corporation, Erie, Pa. This booklet is offered in an endeavor to educate and instruct operators of power pipe machines for better threads and greater production.

High-speed Steel.—The Vanadium Alloys Steel Company, Latrobe, Pa., has recently issued an interesting four-page folder illustrating most forcibly the heavy cuts which may be taken with Red Cut Superior High-speed Steel. The inside pages of the folder are devoted to a large scale photograph showing the tool post, roughing tool and chip taken in a recent test of the new 60-in. Houston, Stanwood & Gamble engine lathe. In this test a 16-in. alloy steel forging was reduced to 12¼ in. in diameter, using a ¼-in. feed at the rate of 15 ft. per min.

Belt Lacing.—The Flexible Steel Lacing Company, Chicago, has endeavored to eliminate the exhaustive technical formulas common to belting problems, and to simplify old practices with proven modern methods by incorporating the most important phases of practical belting practices in separate chapters in a 64-page booklet, entitled "Short Cuts to Power Transmission." The data given, while simple, is accurate and reliable and will be of value to both the engineer and to the man who includes an occasional engineering problem with his other work.

Zin-Ho Portable Air Compressors.—Under this title The Mundie Manufacturing Company, Peru, Ill., has issued a 16-page booklet describing its line of portable air compressors, either gasoline engine or electric motor driven, ranging in capacity from eight cubic feet of free air per minute to 230 cubic feet of free air per minute. The outfits are mounted on channel steel frames with steel wheels and all of the units may be supplied with flange wheels for railroad use, for use in car repair yards, cleaning and painting bridges, drilling rock for the installation of telegraph poles, etc.

The Tank Car.—An unusually important catalog which will be of interest to owners and users of tank cars has been issued by the Pennsylvania Tank Line, Sharon, Pa. In addition to illustrations and specifications of cars as made by the Pennsylvania Tank Car Company, the catalogue contains considerable general information, such as the A. R. A. standards and specifications for tank cars, interchange rules, mileage, demurrage, car accounting records, regulations for the transportation of inflammable and other dangerous liquids, safety appliance standard, and gage tables for contents of tank cars.

Chucks.—"Chucks and Their Uses" is the title of a very interesting and instructive booklet issued by the Skinner Chuck Company, New Britain, Conn. The booklet begins with a history of chucks and the story of their development. Then the various types of chucks and their uses are taken up, each type being explained separately and in detail. Suggestions are offered regarding the proper way to fit a chuck to a lathe and the care of the chuck. An interesting feature of the booklet is a number of succinct and homely "don'ts" that should be of interest to every practical user of chucks.

Railway Cars for Export and Domestic Use.—A very complete catalogue of railway cars of both export and domestic types has been issued by the joint export sales offices of the Magor Car Corporation of New York and the National Steel Car Corporation, Ltd., of Hamilton, Ontario, Canada. The book is well illustrated and metric equivalents of all dimensions are given. A private cable code is also included for the convenience of customers. It is planned to issue other editions later in Spanish, Portuguese and French. This catalog contains 155 pages, 9 in. by 13 in., and is well printed and bound.

Thermalloy High Temperature Castings.—Under this title the Electro Alloys Company, Cleveland, Ohio, has issued a circular describing the properties and uses of Thermalloy, a high chromium alloy which remains unchanged under drastic thermal conditions. Its ability to withstand high temperatures for long periods with freedom from oxidation, bending, warping and cracking on alternate heating and cooling and the ability to cast it in thin sections makes it particularly adaptable for carbonizing and annealing boxes, lead, cyanide and salt pots, pyrometer protection tubes, automatic stoker parts and other objects subjected to high temperature. The material is also readily formed and is machined without difficulty.

Roundhouse Repair Facilities.—The current issue (No. 29) of the Progress Reporter, a booklet issued by the Niles-Bement-Pond Company, New York, is the first of a series of six special railroad numbers to be published by the company at intervals of a few months. It contains interesting and valuable data regarding engine terminals and terminal layouts; also carefully prepared machine tool lists, with recommendations for the arrangement of such tools and facilities. Several roundhouse and repair shop layouts are included, together with a number of clear-cut illustrations showing machine tool equipment in actual operation in locomotive terminals throughout the country, all of which add to the attractiveness of this issue. The five succeeding numbers will cover the following: Smith, Hammer Shop and Foundry; Running Gear Repair; Boiler and Tank Shop; Miscellaneous Machines, Repair Department, and Car Repair Department.

Superheaters for Small Locomotives.—The advantages derived from the use of superheated steam are recognized so generally by railroad motive power officers that it would seem hardly necessary again to call attention to them. Gains equivalent to those obtained from the application of superheaters to large railroad locomotives are being realized on small industrial locomotives of 40 ton weight or under such as are used around industrial plants, in quarries, gravel pits, mines, logging operations, construction work, etc., but as the owners of locomotives of these types are usually not so familiar with the details of locomotive design as are railroad motive power officers, superheaters have not been so generally used on their motive power. Bulletin No. 9 of the Superheater Company shows what has already been accomplished in the industrial field and will be of interest to anyone who is responsible for the purchase or operation of small industrial locomotives.